DIESEL MOTORSHIP OF 22,000 TONS DISPLACEMENT
(FULLY ILLUSTRATED)

NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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MOTORSHIP

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EDITORIAL

GERMAN ACHIEVEMENTS VERSUS AMERICAN LETHARGY

Simultaneously with the first published and illustrated description of the big 22,000 tons German tank motorship "Zoppot," we are enabled to state with certainty elsewhere in this issue that German engineers have completed and run shop-trials of two twelve-thousand (12,000) shaft horse-power marine Diesel-engines, and that these motors are of the double-acting two-cycle type. These engines represent the greatest advance in the modern marine engineering field yet accomplished, and at once brings the economical Diesel oil-engine within the possibilities of large transatlantic liners and warships, and smashes the assertion of many that the internal-combustion oil-motor is limited to moderate-sized freighters. In 1910 the highest-powered ocean motorship was a little tanker of 500 shaft h.p. From 500 to 12,000 horse-power in ten years is wonderful progress. We have just mentioned that this advance virtually makes possible large transatlantic liners. Elsewhere in this issue we have announced the ordering by a leading Italian ship-owning company of six transatlantic combination passenger-cargo liners of 12,000 tons d.w.c. and 8,000 shaft h.p. which will have a speed of 16 knots. Therefore, one might say the transatlantic motor-liner is on the verge of attainment.

In the face of this remarkable development it is obvious that the leading shipbuilders of America must at once wipe off their slate the words, "too overwhelmed with work to build Diesel engines," which, after all, is but an excuse for lethargy or nervousness when we consider the great importance of the ultimate results and when we take into account what Gt. Britain, Italy, Scandinavia and Germany did during the war in the way of big motorships when they were far harder pressed for ships than ever America was. In their own interests and of this nation our shipbuilders must keep apace with European development by quickly securing the best available talent and experience and commence construction of high-powered mercantile Diesel-engines, thus assisting to make our merchant-marine sufficiently economical to keep the seas alongside foreign competition. What Germany and other countries have done during and since the war, American shipbuilders and engine builders should be able to do now. Let them take a little more pride and confidence in their own ability and temper the same with reasonable conservation and boldly set out to do and accomplish their object with the success gained by many firms across the Atlantic.

Shipowners, who now have more funds than ever before, and to whom the success of the American Diesel-engine means so much, must lend financial support and moral encouragement to ship and engine builders without further dallying or otherwise be wiped off ocean trade routes within a few years, and be limited once more to coastwise traffic, while our shipyards will virtually be begging for orders. A non-profitable ship is an exceedingly expensive luxury and money absorber. This is no idle scare-propaganda, but a carefully analyzed view of the near future that shipping men of all maritime nations but the United States clearly see and openly say. Have our shipowners forgotten that hesitation to wholeheartedly turn from wooden sailing-ships to steel steamers once lost us supremacy of the Atlantic, and shall reluctance to advance with the times again spoil America's opportunity on the High Seas by causing history to repeat itself?

What does this latest German progress portray? It means that a transatlantic liner propelled with these two available big Diesel engines (24,000 shaft h.p. aggregate) will have a fuel-consumption of less than 130 tons per day. The economy of such a motorship is almost unbelievable as it compares with 500 tons of coal or 400 tons of oil for a steam-driven liner, while the small spaces needed by the Diesel machinery and fuel will allow of a big increase in passenger accommodation and fuel for a round voyage.

Alternatively the use of one of these engines with its low daily fuel-consumpton brings the 16-knot 15,000 tons d.w.c. cargo-ship within the bounds of almost immediate realization. It no longer is a dream of wild fancy, but is a type of "express cargo-ship" that is an impractical commercial proposition with any class of steam drive. Already Mr. Dan Brostrom has announced that the Götaverken will build the largest Diesel motorship yet laid down, and that this vessel will be operated by the Swedish-American Line. Meanwhile shipowners of the United States are suffering from an attack of lethargic over-cautiousness.

Already hundreds of steam freighters—mostly American—are tied up in Norfolk and New York harbors waiting both fuel and cargoes, and this situation is one we forecasted. The building of motorships will reduce the demand on fuel-oil by more economical use of the present supply and incidentally cause its price to drop, and their greater capacity will enable cargoes to be carried at lower rates with profit.

SENATOR HARDING AND THE MERCHANT MARINE

Politics, as we have often inferred, do not concern this publication unless they have a bearing upon maritime affairs. Because indications tend to point towards Senator Warren G. Harding becoming the next president of the United States his attitude towards the future development and maintenance of our merchant marine is one of great importance to the shipping industry. In the declaration of his policy as outlined in his nomination acceptance speech, Senator Harding said:

> "I believe in a great merchant marine—I would have this republic the leading maritime nation of the world. I believe in a navy ample to protect it, and able to assure us ample defence."

The future success of our maritime commerce will reflect upon the entire welfare of the industries of the country. American ships must carry the products of America, also much of the goods that we import. To uphold our position as a great nation we also should do what we are entitled to, namely—take our place in the world's ocean trading and carry a reasonable share of produce between countries that have but small or no merchant marines. We have spent billions on our merchant fleet; much of that money has been wasted through ignorance and mistakes both in building and operating the ships, but we are a nation that is quick to learn and so are profiting by these errors. Our shipowners and operators are rapidly benefiting by the things for which they have been paying dearly. Another three years or less will see our ships operated in an economic manner, not even exceeded by the British and Scandinavians. And when our ships are all motorships not a nation will be able to beat us at their own game.

CARGO FIRES ON MOTORSHIPS

When the 8,000 tons motorship "Ansaldo San Giorgio III" was discharging a nitrate cargo at Carthagena on June 25th last, the nitrate took fire and in order to extinguish the blaze the vessel was sunk. But on July 2nd she was refloated again and the damage did not seem to be very serious.

Underwriters would do well to bear in mind that in the case of fire on a motorship in harbor she can be sunk immediately without damage to the machinery other than rust, etc., whereas in the case of a steamship the fires have to be withdrawn and the boilers cooled off, otherwise an explosion would occur in the boiler-room which would seriously damage the ship. This results in great delay in sinking the ship, meanwhile the fire gains in intensity and damage. Hence, here is another reason for lowering the fire insurance rates on ocean-going steel motorships. It may be remembered that the 9,400 tons motorship "Tisnaren" was recently sunk in a like manner when her cargo caught fire and was soon raised without damage to her Diesel machinery.

PROPOSED MEETING OF AMERICAN MARINE OIL ENGINE BUILDERS

Recently the American Bureau of Shipping called a committee of all the marine and heavy oil-engine builders in the United States and, while every manufacturer was not there, the gathering was well representative of the new domestic industry. Many important questions were discussed and a technical committee was appointed to handle the various problems connected with the rules and regulations for the construction of engines for merchant-marine purposes.

A situation has been reached which makes it very advisable for American oil-engine builders to get together without delay with other objects in view.

First—To see what additional steps can be taken to change the present lethargy of American shipowners with a view to speeding up prospective orders for new Diesel-driven motor-vessels. Also with a

view to inducing them to convert a number of existing steamships to motor power.

Secondly—To ascertain what action can be taken to counteract endeavors that are being made by other interests to spread anti-Diesel propaganda that tends to damn the reliability and adoption of this economical power.

Thirdly—To see what steps can be taken to make certain that the Federal loan of twenty-five million dollars ($25,000,000.00) per annum for five years is used solely to assist in the construction of *the most modern, the most efficient, and the most economical* type of propelling machinery—namely, the Diesel engine—in accordance with the letter of the law stipulated in Section Eleven of the new Jones' Merchant Marine Act.

If possible, a meeting should be called in New York during September in order that these matters may be fully discussed. To assure that all heavy-oil engine manufacturers are represented we suggest that the various companies communicate with each other and arrange a mutually convenient date and meeting place. A list of American marine oil-engine builders was published in our August issue on page 704. Certain European companies associated with American firms probably could be included with benefit.

Instead of taking advantage of the new Federal loans for motorship construction, four well-known American shipowning companies recently applied to the Shipping Board for permission to build five steam-driven ships of 4,400 to 12,000 tons d.w.c under the excess-profits tax-exemption privilege of Section 23 of the new Merchant Marine Act.

This mystifying action on the part of the American shipowners in question is in the direct face of the great and proven economy and reliability of Diesel power. There must be some reason for the ordering of these uneconomical steamships, and the only one that we can think of is—they still doubt the reliability of the Diesel internal-combustion engine and that they have received insufficient encouragement from shipbuilders to order motor power. Obviously, something must be done immediately by manufacturers to assist the work that MOTORSHIP is doing in putting facts before shipowners. A considerable amount of work lies ahead and concerted action is necessary.

Meanwhile MOTORSHIP will carry on its work and do everything it can to promote the adoption of oil-engined vessels. The provisions of the Jones Act provides American oil-engine builders with a most excellent subsidy if made proper use of, and it is more or less up to themselves to unite and see that the available money is not turned over to any other purpose.

ECONOMY AND FALSE-ECONOMY IN THE DESIGNING DEPARTMENT

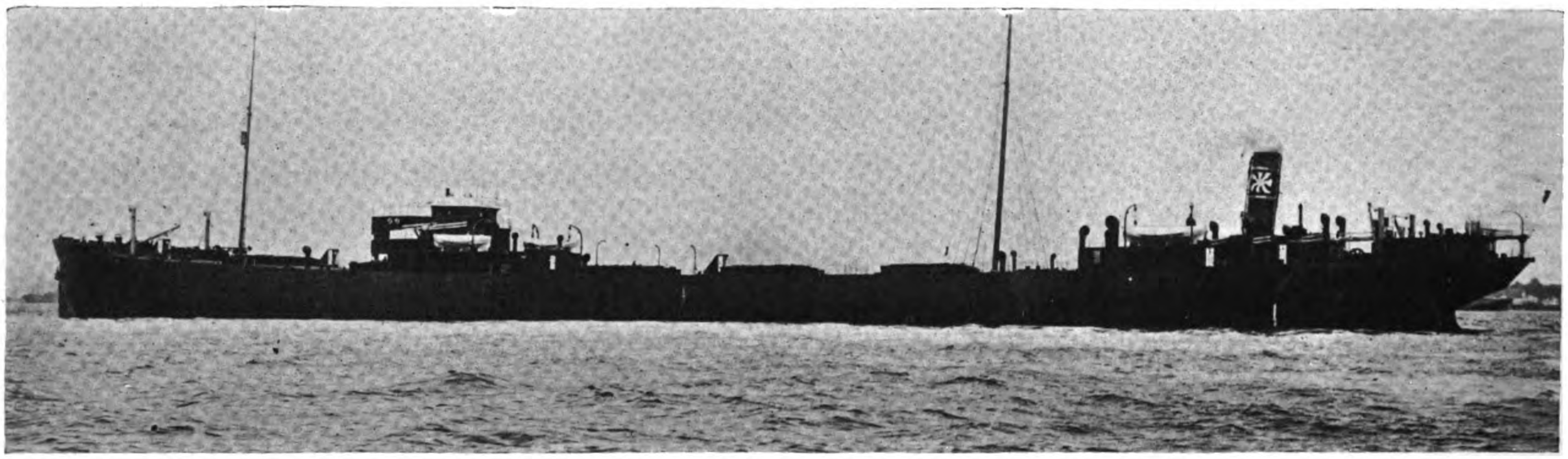
In the earlier days of the recently renewed development of the Diesel-engine in this country several firms fell into the error of not giving sufficient attention to detail work during the designing and construction period. Most of the companies had excellent chief designing-engineers, but inexperienced men have been placed in charge of the drawing and designing of detail parts of the engines, such as cylinders, cylinder-heads, bed-plates, and smaller fittings, they merely copying in a general way and on a larger scale what the chief-designer has outlined. Knowing little about the great importance of engine-detail designing such engines have virtually been failures before they reached the erection shop. This has occurred quite recently too!

It has been partly due to the lack of specially trained men such as are available for such work in European Diesel factories, and partly due to the unwillingness to pay salaries above those required by ordinary engine designers. In Europe there are special "schools" where these detail-designers acquire a thorough knowledge of this particular specialized job. By training and employing such technical men here, fewer changes to parts would have to be made once the first engine is completed. In one or two cases engines have had to be almost rebuilt after ready for the test, solely because of errors in the detail work and the overlooking of certain minor but vital factors in the calculations.

Changes in conditions due to the War and the brilliant prospects of America's virgin Diesel field has caused many of the expert European detail-designing draftsmen to take up their residence here and they have become or are becoming citizens of the United States. Some of these men are not employed in their proper sphere of work. Use of their experiences could be made with advantage by American firms taking up Diesel building and the higher salaries paid would prove good economy in the end.

BRITISH VERSUS AMERICAN SHIP OPERATING

In Great Britain it is not generally believed that America can successfully operate a big merchant marine, but all is not honey over there—the shore-laborers will not coal when it is raining, altho they have no objection to sitting fishing from the stern of the ship in the rain.



Broadside view "Zoppot" largest motorship in the world. She is Diesel-driven oil-carrying tanker

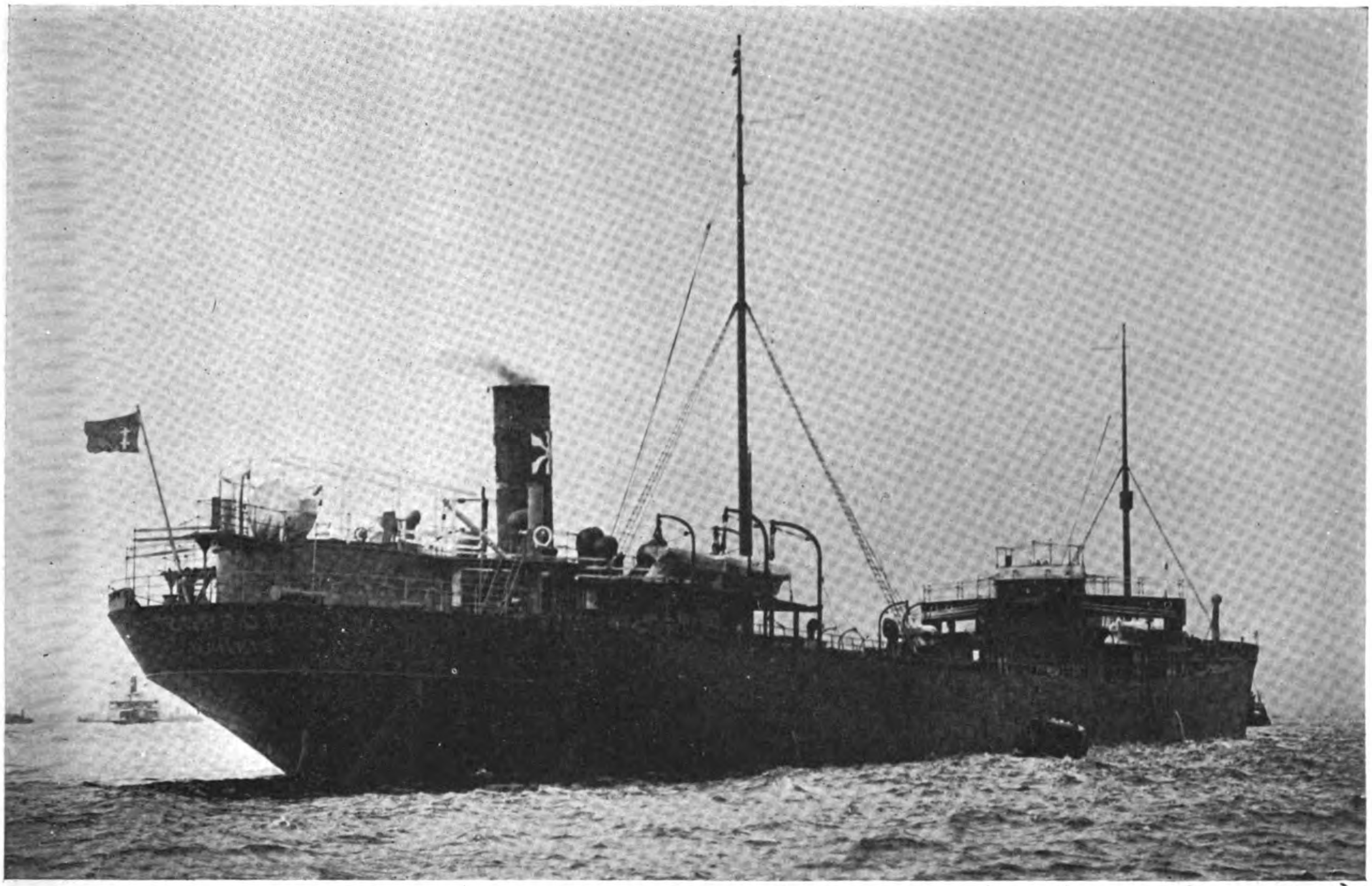
Biggest Motorship in the World Arrives at New York

Krupp-Built 17,000 Tons D.W.C. Diesel-driven Tanker Averages 11½ Knots on Maiden Voyage from Germany

ONE of the most interesting motorships that have visited New York harbor for a long while is the big Diesel-driven tanker "Zoppot" owned by Standard Oil interests and which up to the present ranks as the largest motorship afloat altho not the highest powered. That American money has been to a considerable extent invested in her construction is of some credit to the enterprise of one of our largest oil-companies. Nevertheless, a certain amount of credit is due to the German branch of the oil company who strongly encouraged her development, and to the German firm who designed and built her.

The "Zoppot," as this motorship is named, was originally built at Krupp's Germaniawerft, Kiel-Gaarden, in 1913-14, to the Isherwood system, but the war broke-out before her trials were run so the vessel was laid-up until cessation of hostilities. Then her builders decided to incorporate into her construction later experiences in Diesel-engine design and construction available during the interim period, and so practically rebuilt the engines from the upper part of the crank-case to the top of the cylinder-heads, and this particular section of the engine is very superior to the Krupp Diesel engines installed in the tank motorships "Glenpool" (ex-"Hagen"), "Loki" and "Baku" which are of 7900 tons d.w.c. But, the lower part of the engine is practically the same, and force-feed lubrication is only used on part of the engine.

The "Zoppot" is now owned by the Baltic-American Petroleum Import Company of Dantzig and flies the flag of the new state of Dantzig. Originally she was named "Wilhelm A. Riedemann" and was owned by the German-American Petroleum Company, of Hamburg,—also a Standard Oil subsidiary. She has the following dimensions:



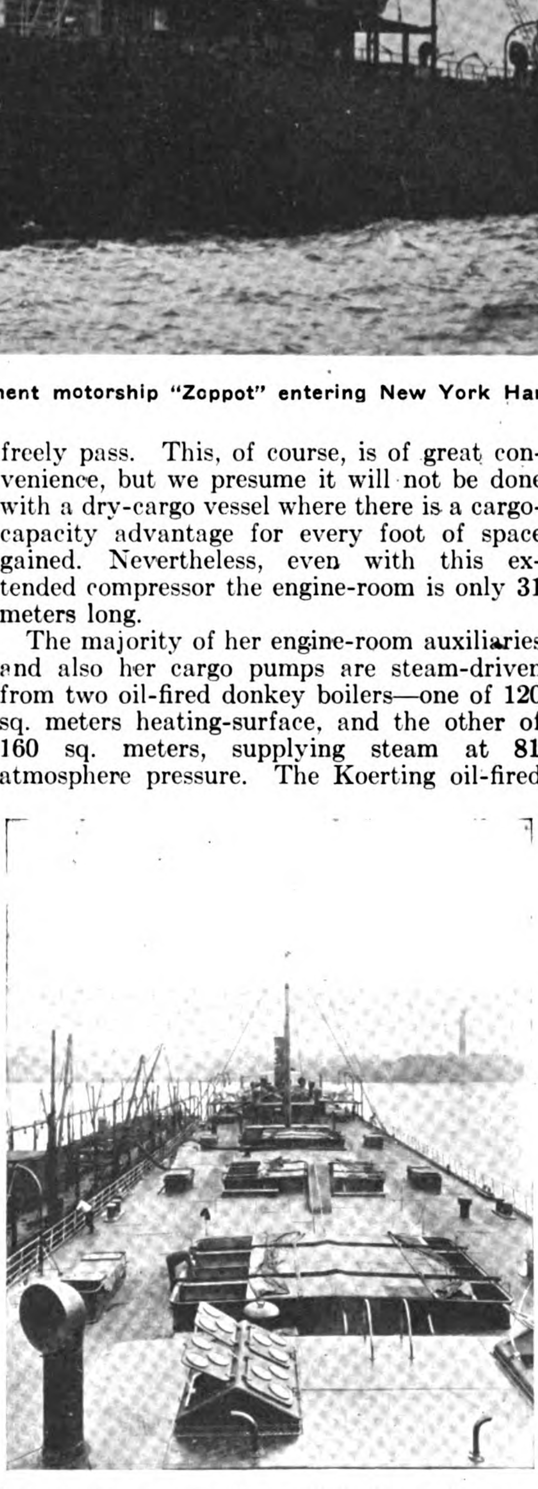
The 22,000 tons displacement motorship "Zoppot" entering New York Harbor on her maiden voyage

Loaded displacement	22,000 tons
Length (O.A.)	545 ft. 0 in.
Length (B.P.)	525 ft. 0 in.
Breadth	66 ft. 3 in.
Depth to shelter-deck	41 ft. 3 in.
Depth to Main-Deck	33 ft. 6 in.
Dead-weight-capacity	16,800 to 17,000 tons.
Draught	27 ft. 9 in.
Metric-capacity	15,227 metric-tons
Total cargo-capacity	693,329 cu. ft. (with 3% expansion allowance
Power	4,000 Indicated h.p.
Number of cylinders	6
Bore & Stroke	575 mm. by 1,000 mm
Designed engine-speed	106 R.P.M.
Average revolutions on maiden voyage	102 R. P. M.
Length of engine-room	31 meters.
Trial speed	12 ½ knots.
Average speed (light)	11 ½ knots.
Daily fuel-consumption	12 to 13 tons.
Fuel-consumption	136 grams. per i.h.p. hour.

Because a special article dealing with the machinery of this ship is now being prepared especially for "Motorship" by Herr Otto Alt, Chief-engineer of the Diesel Engine Department of Krupp's Germaniawerft, Kiel-Gaarden, Germany, we do not propose to fully describe this vessel in this issue, particularly as we are very closely pressed for space. Through the courtesy of Mr. Kurt Von Sanden, guarantee-engineer from the Krupp factory, we were able to make a very interesting inspection of the ship and her engines.

Being a tanker the engines are, naturally installed aft. Because of the limited amount of cargo that an oil-tanker can carry on given dimensions there naturally is plenty of room for the engines. By reason of their smallness in size there is "room to burn," and while the two-cylinder, three-stage compressor on each engine is driven off by an extension at the forward ends of the crank-shaft, a space of about 6 ft. between the compressor and the engine has been allowed in order to provide a gangway through which her engineers may freely pass. This, of course, is of great convenience, but we presume it will not be done with a dry-cargo vessel where there is a cargo-capacity advantage for every foot of space gained. Nevertheless, even with this extended compressor the engine-room is only 31 meters long.

The majority of her engine-room auxiliaries and also her cargo pumps are steam-driven from two oil-fired donkey boilers—one of 120 sq. meters heating-surface, and the other of 160 sq. meters, supplying steam at 81 atmosphere pressure. The Koerting oil-fired system is fitted to these boilers, together with turbo blowers. These boilers also supply steam to the steering-gear when in harbor. However, when the "Zoppot" is at sea the the steering-gear is operated by compressed-air which is supplied hot to the steering-gear, there being no after-cooler on the last stage of the compressor. The Diesel-engine operating the compressor is a 3-cylinder four-cycle Krupp model of 240 b.h.p. at 240 r.p.m. and it is direct-coupled to a twin-cylinder, three-stage Koester air-compressor without valves on the lower stage, delivering air to the storage tanks at 60 to 70 atmospheres pressure.



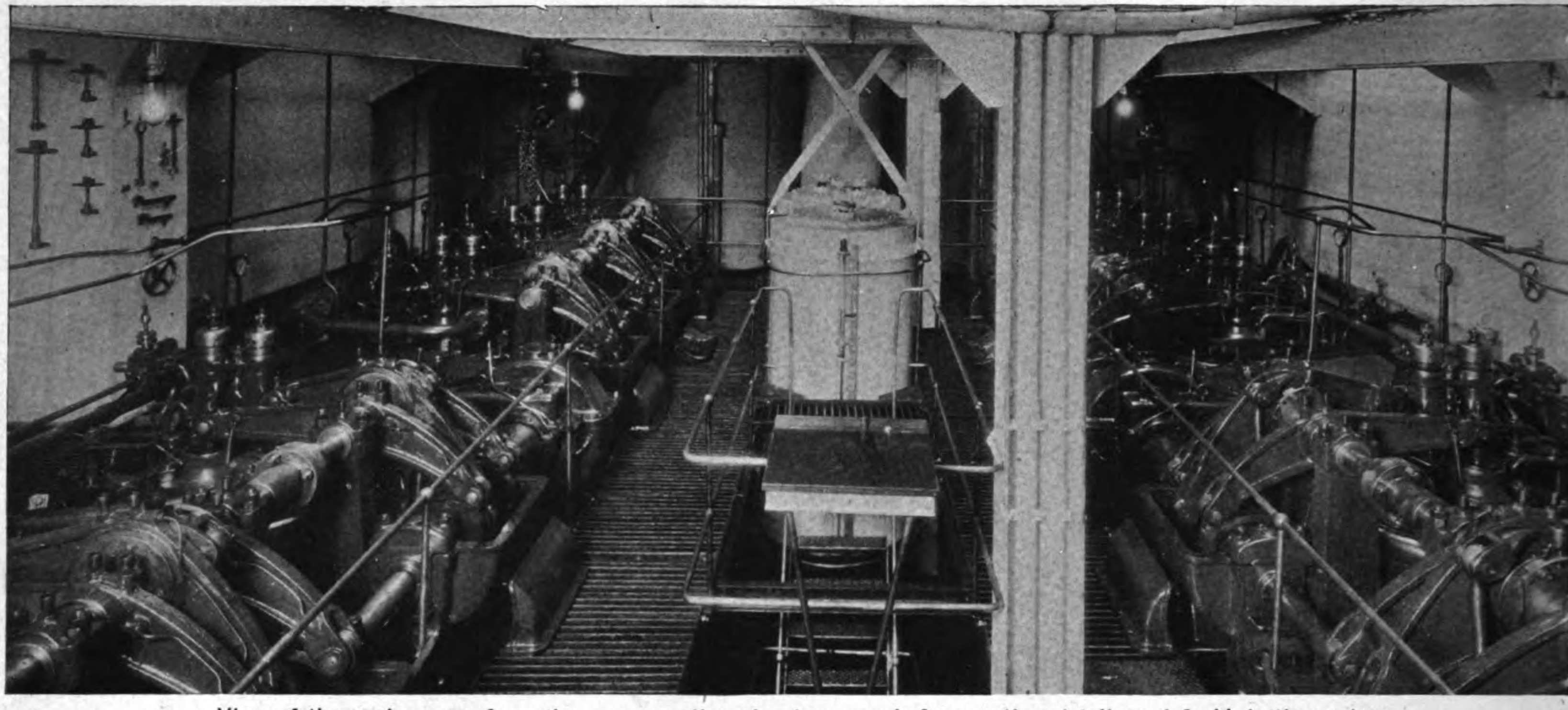
Deck of motorship "Zoppot" looking aft from the bridge which is about 70 ft. forward midships. An idea of the size of this ship can be obtained from this view as it represents approximately five-eighths of her length.

Furthermore, there is a Swiderski surface-ignition oil-engine of 35 h.p. coupled to a Siemens-Schuckert 27 k.w. 110 vol. generator turning at 330 r.p.m. for electric-lighting the ship.

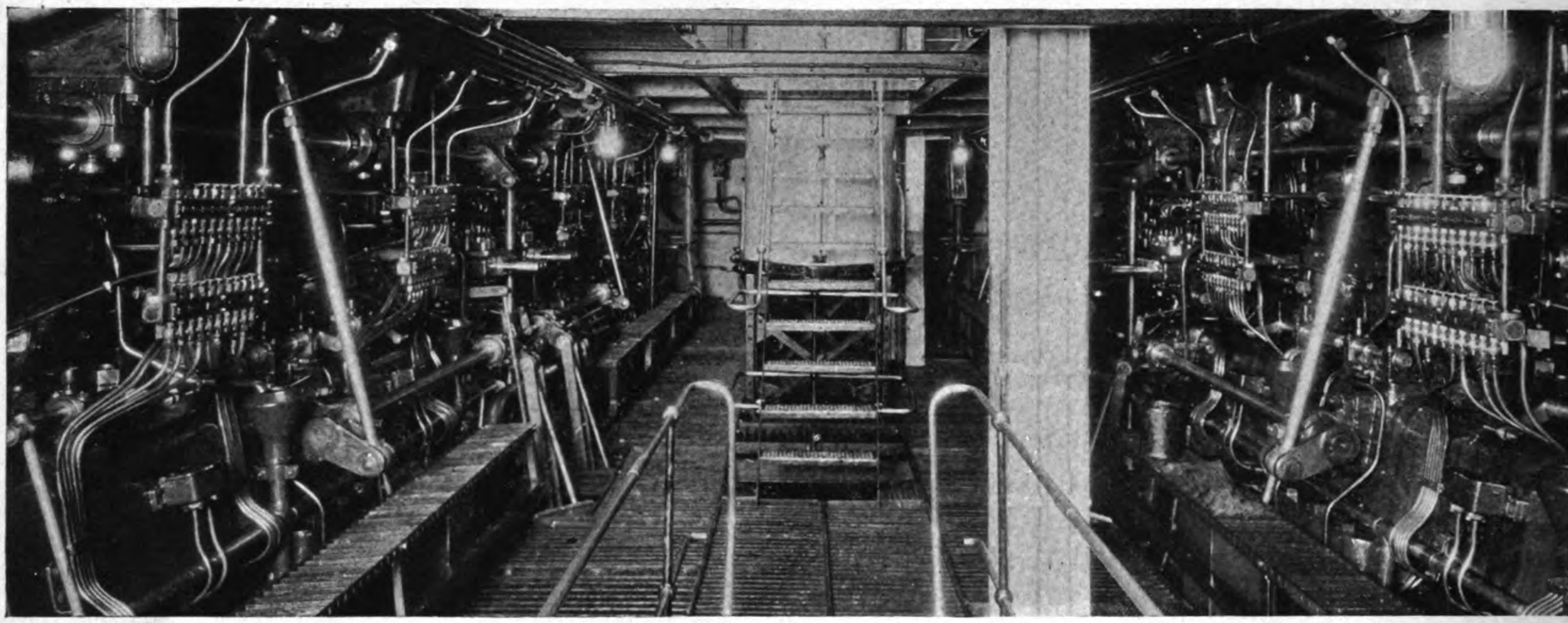
As we have mentioned we do not propose to describe the twin 2000 i.h.p. main Krupp two-cycle single-acting Diesel-engines at this time because of the article by Herr Alt, which we anticipate publishing in our October issue together with more complete illustrations. But we must not omit to mention that the valve-in-head scavenging system has been retained, but two fuel-injection valves have been mounted side-by-side in one cage in the cylinder-head. On the voyage over gas-oil of 0.87 specific gravity was used as fuel.

Present day practice with engines of this size is to use built-up crankshafts, but the crankshafts of the two Krupp engines of the "Zoppot" are solid-forged in two pieces—the crank-pins and the crank-shaft being 390 mm. in diameter and the shaft is constructed in two sections, each having three cranks.

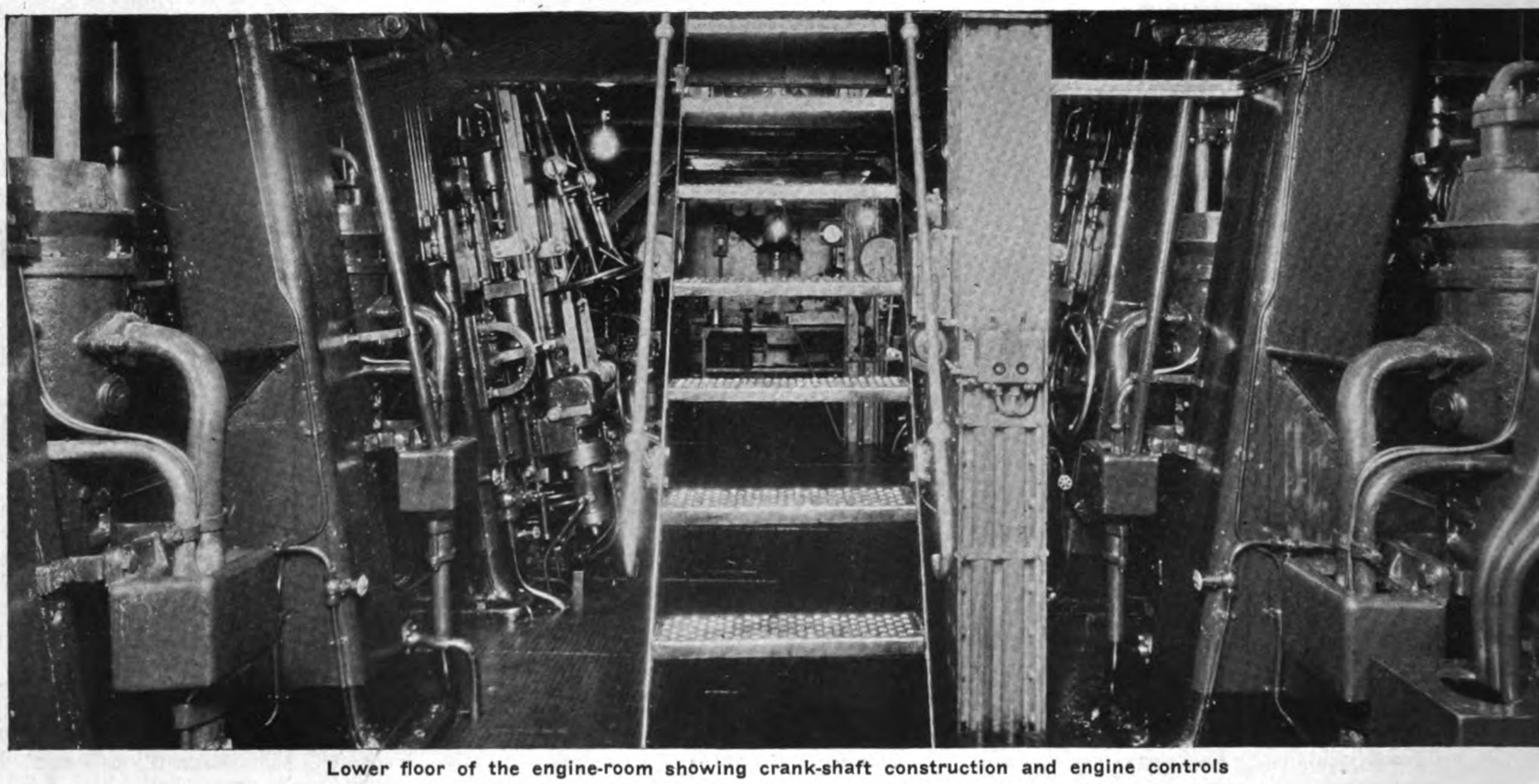
Between the two main engines there are two small feed tanks each of 4 hours' capacity, and these are filled from the day tanks and thus accurate fuel-consumptions can be



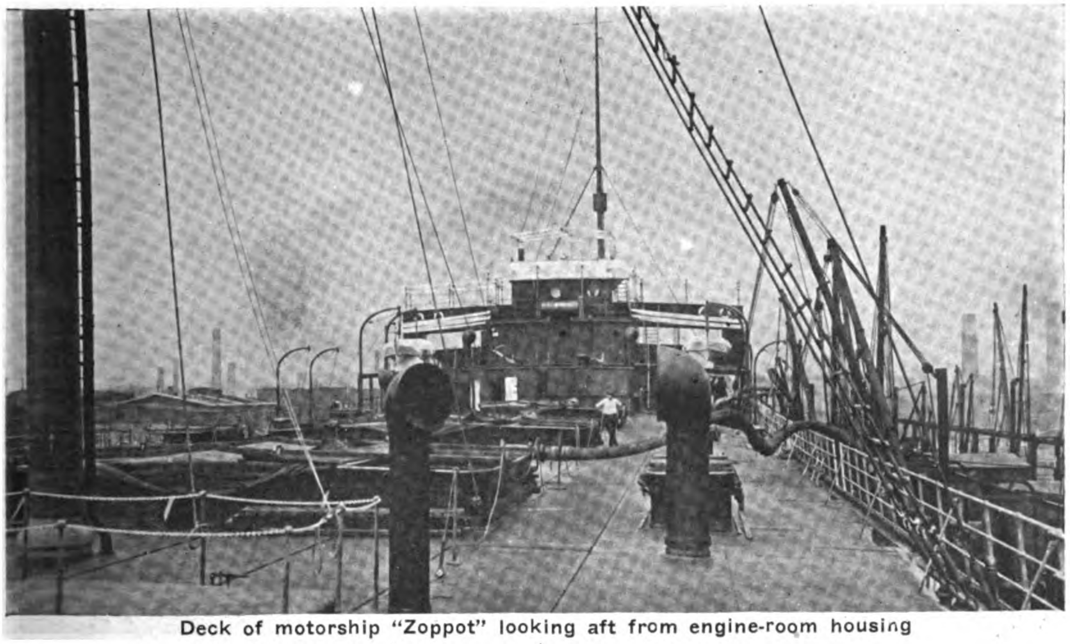
View of the engine-room from the upper grating showing cam-shaft operating details and fuel-injection valves



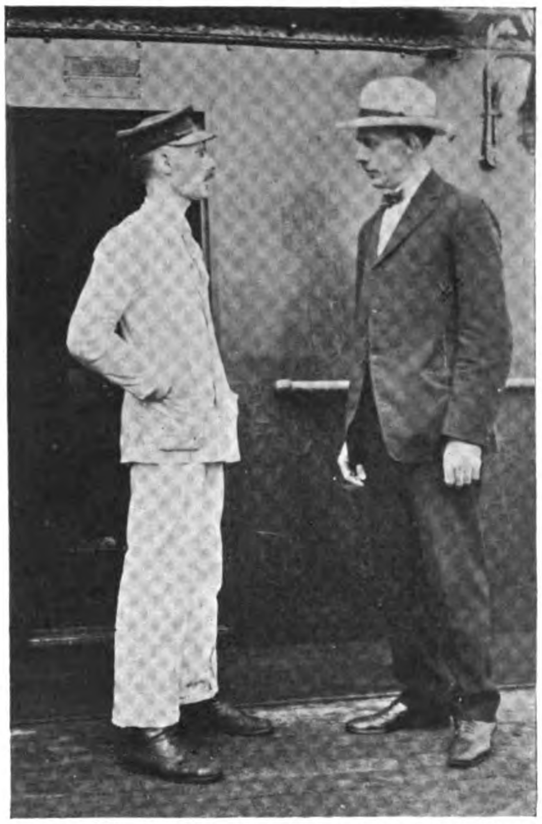
Engine-room from the second stage grating showing lubricating arrangements



Lower floor of the engine-room showing crank-shaft construction and engine controls



Deck of motorship "Zoppot" looking aft from engine-room housing



Mr. Kurst Von Sanden, Guaranty-Engineer from Krupps tells Mr. John Nichols, Chief-Engineer of the Newport News Shipbuilding & Dry Dock Co. about the very successful voyage from Germany

measured, one of the two feed tanks being in operation each alternate four hours.

The hull as mentioned is built on the Isherwood system, and a remarkable feature of the construction can be seen in the engine-room. Running fore and aft over the center of the two main engines is one of the largest and strongest steel girders we have yet seen in hull construction. Undoubtedly this forms the backbone of the after part of the ship, which should add considerable strength to the entire hull and assist to eliminate any vibration from machinery, particularly when the vessel is run in ballast.

We were informed that the engine-room auxiliaries instead of being steam-operated as at present, are to be changed to Diesel-electric, and for this purpose an additional auxiliary Diesel-engine will be installed when she returns to Europe.

The "Zoppot" has left New York and is now en route for Hamburg. On the maiden voyage to the United States a long run was made without a single stop of either engine at an average of 11½ knots speed, and not a single repair was necessary upon her arrival here. No machinery trouble of any kind was experienced en route.

DIMENSION COMPARISON OF WORLD'S LARGEST MOTORSHIPS

(The vessels below are in actual service.)

	"ZOPPOT" (Germ. Amer.)	"MAUMEE" (Amer.)	"GLENOGLE" (British)	"AFRIKA" (Danish)	"GLENAPP" (British)	"CUBORE" (American)
Displacement (Loaded)	22,000 tons	15,000 tons	19,000 tons (abt)	18,600 tons	19,000 tons	17,000 tons (abt)
Dead-weight Capacity	17,000 "	10,000 "	14,000 "	13,250 "	9,600 tons & 1,700 troops	11,500 "
Cubic-Capacity	693,329 C.F.	Not available	Not available	872,300	Not available	Not available
Length (O.A.)	545′ 0″	" "	502′ 0″	464′ 4″	470′ 0″	469′ 0″
Length (B.P.)	525′ 0″	455′ 0″	485′ 0″	445′ 0″	450′ 5″	450′ 0″
Breadth	66′ 3″	56′ 0″	62′ 2″	60′ 0″	55′ 8″	57′ 0″
Depth	41′ 3″	Not available	27′ 5″	42′ 0″	40′ 0″	37′ 0″
Draught (Loaded)	27′ 9″	26′ 0″	27′ 2″	Not available	Not available	Not available
Power	4,000 I.H.P.	6,400 I.H.P.	6,600 I.H.P.	4,000 I.H.P.	6,600 I.H.P.	3,200 I.H.P.
Twin or Single Screw	Twin	Twin	Twin	Twin	Twin	Single
Type of Diesel Engine	Two Cycle	Two Cycle	Four Cycle	Four Cycle	Four Cycle	Two Cycle
Loaded Speed	11½ Knots	14 Knots	13 to 14 Knots	12 Knots	15 Knots	11½ Knots
Trial Speed	12 1-5 Knots	Not available	Not available	13¼ Knots	Not available	Not available
Gross Tonnage	9,700 tons	" "	9,150 tons	9,050 tons	7,263 tons	7,000 tons
Net Tonnage	5,700 tons	" "	Not available	5,468 "	4,623 "	Not available
Daily Fuel Consumption	12 to 13 tons	20 tons	20 tons	13 tons	20 tons	17 tons

Two 12,000 Shaft H.P. Diesel Engines Completed in Germany

A Great Marine Engineering Achievement

READERS of several years ago will remember that in Germany two big engineering concerns commenced the construction of very large Diesel engines with a view to installing the same in a battleship. "Motorship" is enabled to make an exclusive announcement that these two engines are now completed and have run tests. Each of these big engines develop 12,000 shaft horsepower from six double-acting cylinders on the two-cycle principle, and is direct-reversible. Generally speaking, we understand, the tests were successful, but further experiments and tests will have to be made owing to the tendency of the lower covers to crack. But, no trouble is being experienced in keeping the glands tight through which the piston-rod passes.

One of these engines has been completed at the works of the Fried Krupp A. G., Kiel-Gaarden, and the other at the Nürnberg plant of the Maschinenfabrik Augsburg-Nürnberg, (M. A. N.). Unfortunately, owing to the general conditions in Germany, and as they are owned by the Navy Department it is not likely that both engines will be installed in one big merchant-ship. It is expected that the Nürnberg engine will be installed in a battleship converted to a large tanker. However, the matter is not yet settled.

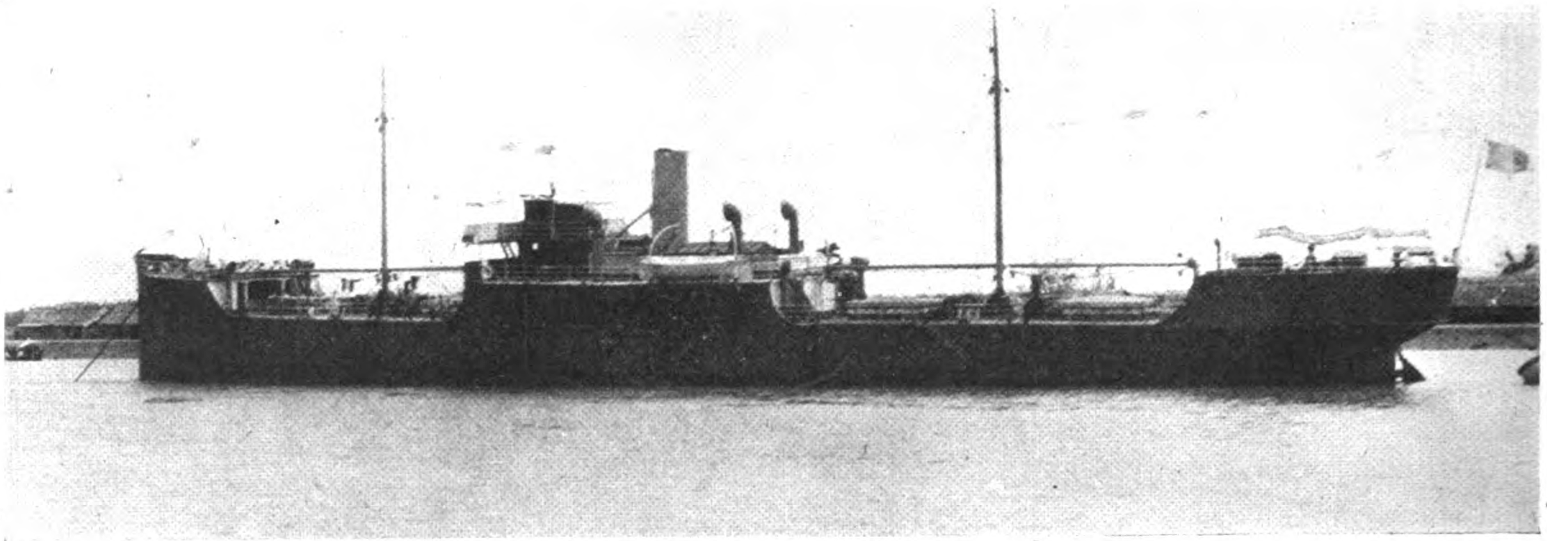
Krupps are building twelve (12) six-sylinder reversible merchant-marine four-cycle type Diesel engines of 1250 shaft h.p. each, and six (6) Diesel engines of 700 h.p. at 75 to 90 revs. per minute. These also are of the four-cycle type with six-cylinders 500 mm. bore by 900 mm. stroke. They may be installed in a small fleet of German built motorships to be owned and operated by the Peoples Trading & Industrial Company, of New York, N. Y. Two of the larger reversible marine engines have gone to the town of Hemsjo, Sweden, where they are to be used for a while in a power station.

SIX HIGH-SPEED TRANSATLANTIC MOTOR-LINERS ORDERED

We are able to announce that the Societa Nazionale di Navigazione, of Genoa, have ordered six 12,000 tons combination passenger-cargo motor-liners from Ansaldo San Giorgio of Spezia, Italy. These vessels are the highest powered yet ordered by shipping company, and they will be propelled by Diesel-engines aggregating 8,000 shaft h.p. (equivalent to 9,000 steam i.h.p.). The Diesel-engines will be of the Ansaldo San Giorgio two-cycle direct-reversible type, each having six single-acting cylinders. The speed of these vessels will be 16 knots.

At last the "express" type motorships suggested by ourselves to the United States Senate Committee on Commerce have been ordered—but, unfortunately, not by an American firm.

The operation of the first three 8,100 tons motorships of the Societa Nazionale di Navigazione, namely, the "Ansaldo San Giorgio I, II and III," have given the owner sufficient confidence to order not one record-motorship, but six.



"Cochinchine," the world's largest concrete motorship. This vessel is of 2200 tons d.w.c. and is propelled by twin 500 b.h.p. McIntosh & Seymour Diesel engines and is constructed under a new system which greatly reduces the weight. Her builders were the Societe Indochinoise de Constructiones Navales of Saigon, Indo-China

World's Largest Concrete Motorship

Noteworthy Chinese Vessel Propelled by American Diesel-Engines

That the U. S. War Department has seven concrete Diesel-engined motorships of 900 shaft h.p. now under construction, adds to the interest in the largest concrete motorship that has yet been constructed in any country, particularly as this vessel has been Diesel-engined by an American concern. We refer to the "Cochinchine," which recently ran her maiden voyage in the Far East. She is a cargo and passenger vessel of 2000 tons deadweight, capacity, so is 800 tons larger than the Danish concrete motorship, "Triton," illustrated and described in "Motorship" for June, 1920, which by the way is of 450 shaft h.p. with a single screw.

Reference to the construction of the "Cochinchine" was made in this journal some time last year, and at the occasion we mentioned that she was being built under a new system which greatly reduces the weight, and is said to be as light as the average steel-ship. Her constructors were the Société Indochinoise de Constructiones Navales of Saigon, Indo China (Brossard & Mopin), and the only wood used in the structure is the pilot-house, just forward of amidships.

Her dimensions are as follows:

Dead-weight capacity	2200 tons
Length (overall)	228 ft. 0 in.
Breadth (moulded)	38 ft. 0 in.
Draft (loaded)	18 ft. 9 in.
Draft (light forward)	11 ft. 8 in.
Draft (light aft)	13 ft. 10 in.
Power	1280 i.h.p (1000 shaft h.p.)
Trial speed	10.5 knots
Engine-room crew	Three white-men and ten Orientals

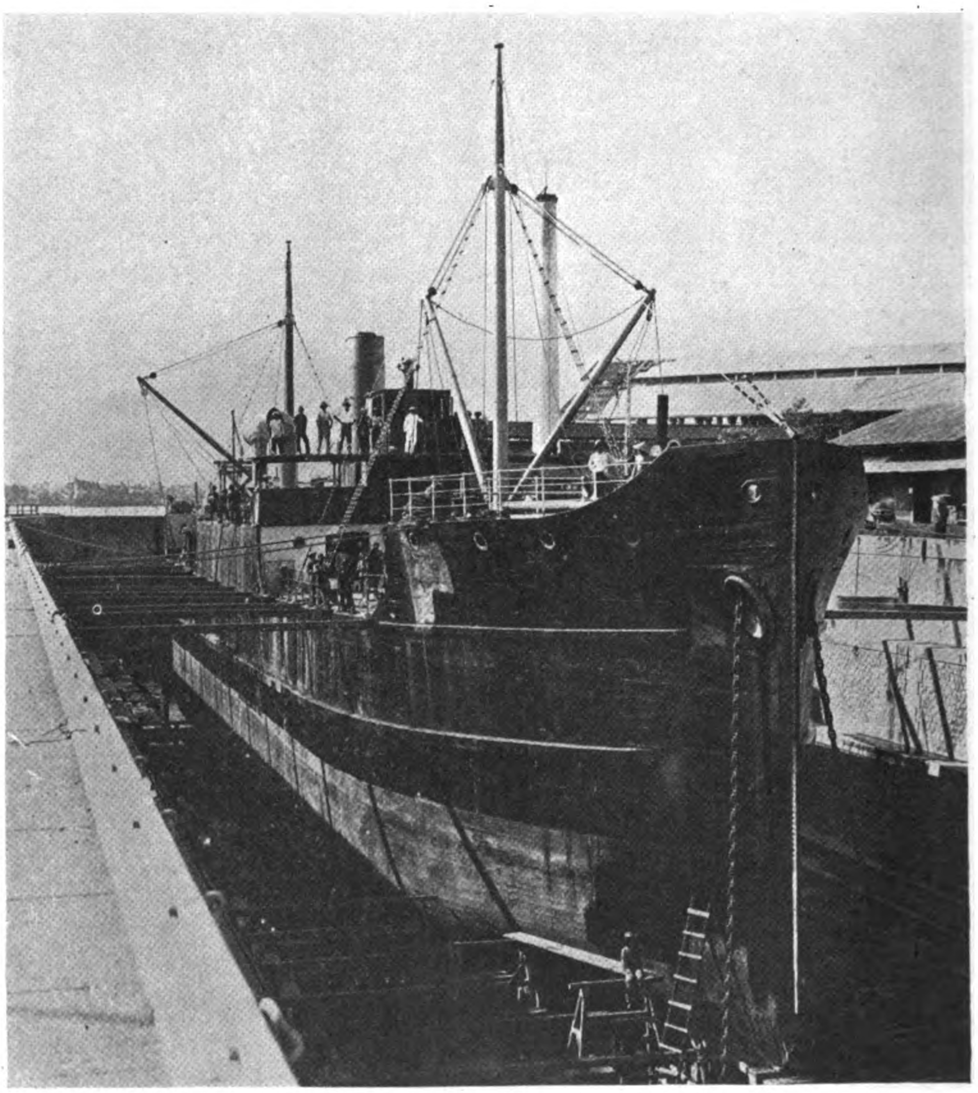
She is fitted with two six-cylinder 630 i.h.p. McIntosh & Seymour four-cycle type marine Diesel engines.

There are four cargo-holds and there is a double-bottom with six water-tight bulkheads, and the space forward of No. 1 bulkhead and aft of No. 6 bulkheads of the double-bottom is used as ballast-tanks, while the spaces under No. 1 and 2 holds are used for fresh-water storage, and spaces No. 3 and 4 are used as oil-fuel tanks. Bunkers for lubricating-oil and coal are constructed of concrete and are placed under the engine-room.

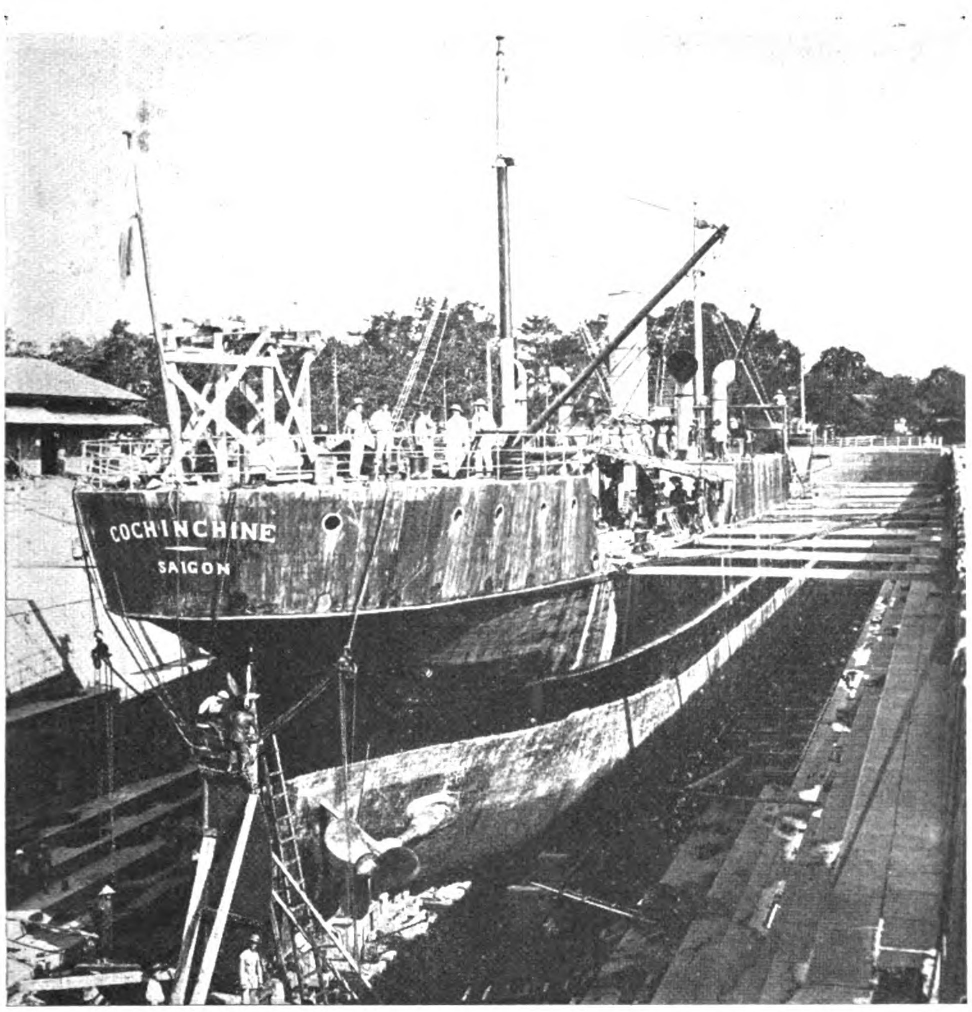
Accommodation is provided for sixteen first-class and for twelve second-class passengers. We have no details of the exact amount of weight of cargo that this ship can carry, but on her maiden voyage 1200 tons of rice were carried. The trial trip run previous to the maiden voyage was from Saigon to Cape St. James, and return; also a run over the measured mile and a 10-mile trip out to sea—altogether a distance of 100 miles. During the run over the measured course, the port engine averaged 188 r.p.m. and the starboard engine 192 r.p.m., the speed of the ship figuring out 10.5 knots as just mentioned.

A total fuel-consumption of 56.25 gallons or 1.34 barrels per hour was registered, the port engine using 1/4 gallon per hour more than the starboard engine. No indicated powers are available to us, but assuming that the engines were developing their normal rating of 630 i.h.p. each, the fuel-consumption figures out to be 0.33 lb. per indicated h.p., or 0.43 lb. per shaft h.p., as it would mean a total daily-consumption of 32 barrels, or 4½ tons. Compared with the fuel consumption of America's steam-driven concrete ships this is a most remarkable result.

During the entire run, neither engines were stopped except to put-off and take-on pilots. Considering the engine-room crew were all new men and ten out of the thirteen were Chinese, these results may be considered very excellent.



Bow view of the concrete motorship "Cochinchine"



Stern view of the "Cochinchine"

Three days after the trial trip, the "Cochinchine" left for Singapore, Straits Settlement, with 1200 tons of rice aboard, the distance of the voyage being 625 nautical-miles. There were several stoppages due to presence of water in the fuel-oil, but no engine trouble was encountered on the entire trip. An average speed of 9.6 knots was maintained, the time taken being 65 hours. At Singapore, the rice was discharged and 600 tons of general-cargo was taken aboard and the ship proceeded to Saigon. On this run she averaged 10.2 knots, without any suggestion of engine trouble. Furthermore, there was absolutely no vibration in the engine-room, and what is even more interesting under the circumstances, there was no creaking or groaning such as is usually noticed in wooden and steel ships, when they roll in heavy seas. Furthermore, no trouble was experienced from grit or sand in the oil-tanks.

In addition to the main Diesel engines, there is a boiler of approximately 125 h.p. for supplying steam for operating the deck winches and windlasses. There are two 15 kw. Fairbanks Morse surface-ignition oil-engine driven electric generating sets for electric lighting and for operating the pumps.

Her pumping equipment consists of two Goulds, electrically-driven cooling-water circulating-pumps, two 25 b.h.p. Norwalk air-compressors which provide air for steering and manœuvering, and two McKinney fuel-oil transfer-pumps, also electrically driven. There is also a small steam driven Rix air-compressor for air injection of fuel used as auxiliary to the compressors on the main Diesel engines.

In addition to the foregoing pumps, there are four steam-operated pumps supplied by the Westinghouse Company, of East Pittsburgh, Pa. One of these is for ballast and fire, another for the bilge, one for the donkey-boiler feed, and the fourth for sanitary purposes. The donkey-boiler is oil-fired by the "Best" system. Her propellers were designed and furnished by the Trout Company of Buffalo, while the steel masts were made by the Morse Dry Dock & Repair Company of Brooklyn.

On deck there are six steam winches working her four cargo holds. These were made by the American Clay Company, as also were the steam capstan and steam steering-gear. In the engine-room the crew consisted of three white engineers, three watch-keeping Chinese, three Chinese oilers, one Chinese mechanic for general repairs, and three Chinese firemen. The latter are necessary for maintaining steam in the donkey-boiler both in harbor and at sea one man per watch being required for the same, even though the donkey-boiler is oil-fired.

JOHN F. NICHOLS LEAVES FOR EUROPE

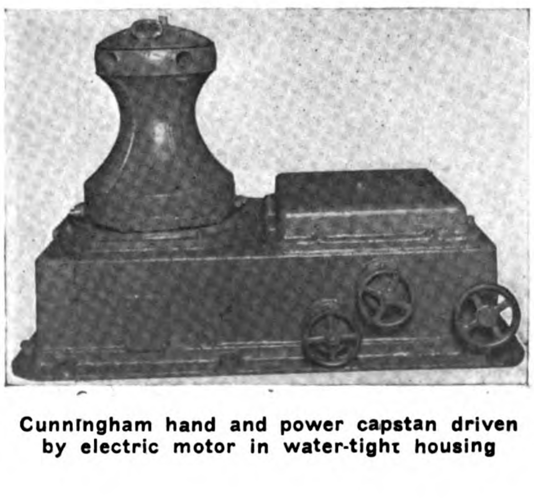
On August 21st Mr. John F. Nichols, Chief-engineer of the Newport News Shipbuilding & Dry Dock Co. left for Europe to consult with the Werkspoor engineers regarding their modified design of 2,000 i.h.p. merchant marine Diesel engine which they will very shortly commence to construct under Werkspoor license, the work having been authorized by the Board of Directors. Mr. Nichols will take the opportunity to tour other countries and study European motorship operation and Diesel engine practice.

Electric Auxiliaries of the "Benowa" Class of Motorships

Engine-Room and Deck Equipment as Developed by a Pacific Coast Firm—Great Economies Effected Compared with Sister Motorships with Steam Auxiliaries

It was intimated in our last issue that only a few American manufacturers of electrical machinery have displayed interest in drawing the attention of ship-owners and shipbuilders to the special value of this type of prime-mover for the purpose of operating the engine-room and deck machineries of motorships.

Yet electrical auxiliaries are fundamentally correct for motorships with slow-speed reversing Diesel engines; for motorships with Diesel electric-drive system of propulsion; for motorships with directly-reversible surface-ignition engines, as well as for steamships using steam-turbine driven generators with electric-transmission to a motor on the propeller-shaft. In fact, the market for electrical auxiliaries in connection with motorships even at the present time offers a far greater field than does the use of this class of machinery in connection with steamships. Because, whether electrical auxiliaries are adopted with a steamer or not, she must have her usual equipment of boilers, whereas with motorships no boiler of any kind is needed, not even for heating purposes if the electrical equipment is as complete as installed on many modern motorships, notably the "Solitaire," owned by the Texas Steamship Company, and in many of the big passenger and cargo motor-liners owned by European companies.



Cunningham hand and power capstan driven by electric motor in water-tight housing

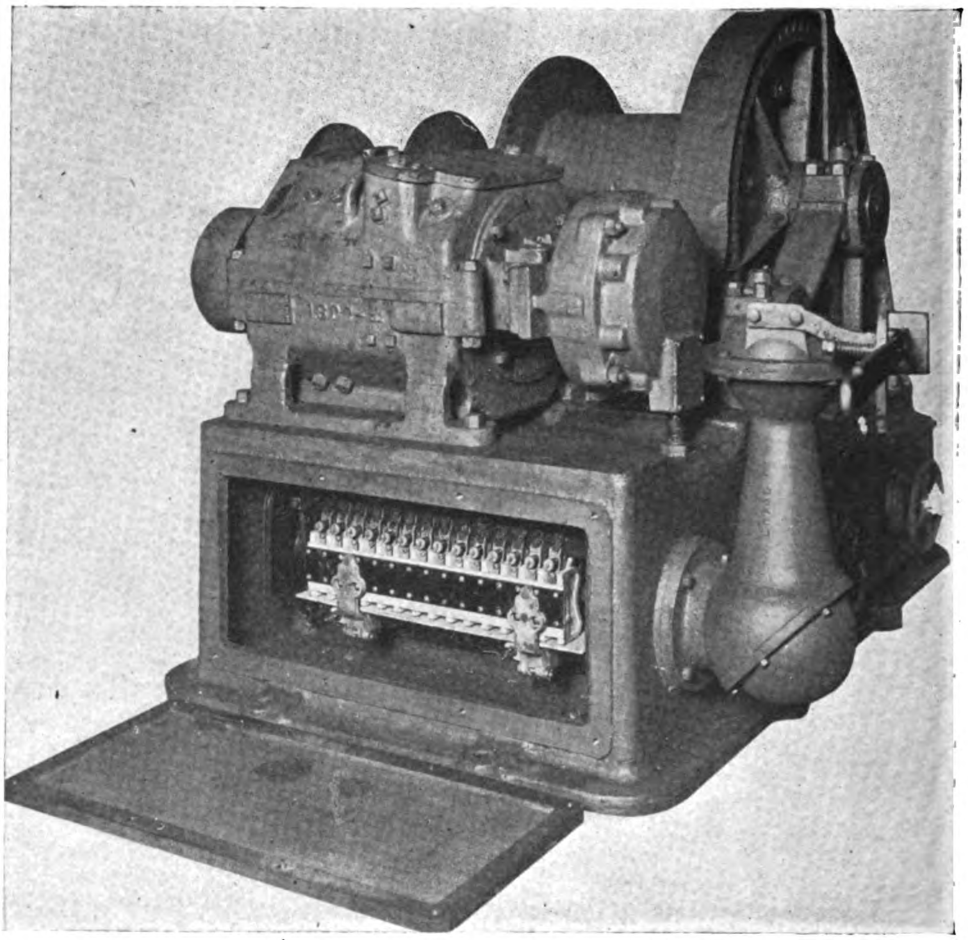
No steam need be generated even for the purpose of smothering possible fires on oil-tankers or in the cargo-holds of freighters, because the available chemical systems for fire extinguishing are very efficient, especially when augmented by high-pressure electrically-driven fire water-pumps. In fact, the only case where steam is needed aboard a modern motorship is where a tanker has to carry a very thick oil-cargo which must be heated by steam-coils before it can be pumped. Even in such cases as this it may be possible in many instances to have a connection from the steam coils to the deck, and connect with a boiler on shore, and heat-up the heavy oil-cargo in this way.

Another method is to utilize the hot exhaust-gases from the main Diesel engines to keep the cargo in a fluid state the entire time the ship is at sea, either directly through pipe-coils, or by running the exhaust-gases under a donkey-boiler and generating steam at 100 lbs. pressure as in the case of the Anglo-Saxon Petroleum Co.'s motor tankers. In some cases it may be necessary to augment the quantity of steam thus generated by an oil-fired jet when the ship is in harbor and the main engines are stopped.

These factors offer adequate reasons why the majority of present-day motorships should be electrically equipped from stem to stern in as far as the auxiliary machinery is concerned. The underlying principle of the electrical method of drive is economy of fuel-consumption, which tends to provide greater cruising radius and increased cargo carrying-capacity and engine-room auxiliaries selected for this purpose must necessarily follow this principle for a given size of vessel. Therefore, the deck or else detract from the earning ability of the vessel as a whole.

Generally speaking, electrical auxiliaries on a motorship secure power from one or more auxiliary heavy-oil internal-combustion engines driving generator sets, and using the same grade of fuel as the main propelling Diesel engines. In the case of Diesel-electric propulsion, one of the several main units is utilized to supply electric energy for both the deck equipment and the auxiliaries in the engine-room, when in port. While at sea, the power is taken via the switch-board. In port, the power required during the period that the deck-winches are handling the cargo is on an average about three times the amount required with auxiliaries at sea. Also because a certain amount of engine-room auxiliaries, such as lighting of the ship and the circulating, bilge and general-service pumps are in constant use.

Steamships with turbo-electric propulsion are not so well off in this respect, as it is too uneconomical to use one of the main engines in port, so one or more auxiliary turbo-electric generators are required for the auxiliary machinery.



Cunningham electric cargo-winch showing water-tight compartment for controller. The electric-motor also is water-tight. Only one operating lever is required

On the Pacific Coast, a well-known electrical company have for nearly six years been studying the construction and observing the operation of electric machinery for motorships, and during the last two years have equipped 24 motorships with machinery of this class, and at present are at work on a similar mechanism for two Skandia-Werkspoor Diesel-driven motor-tankers now under construction for the Standard Oil Company of California.

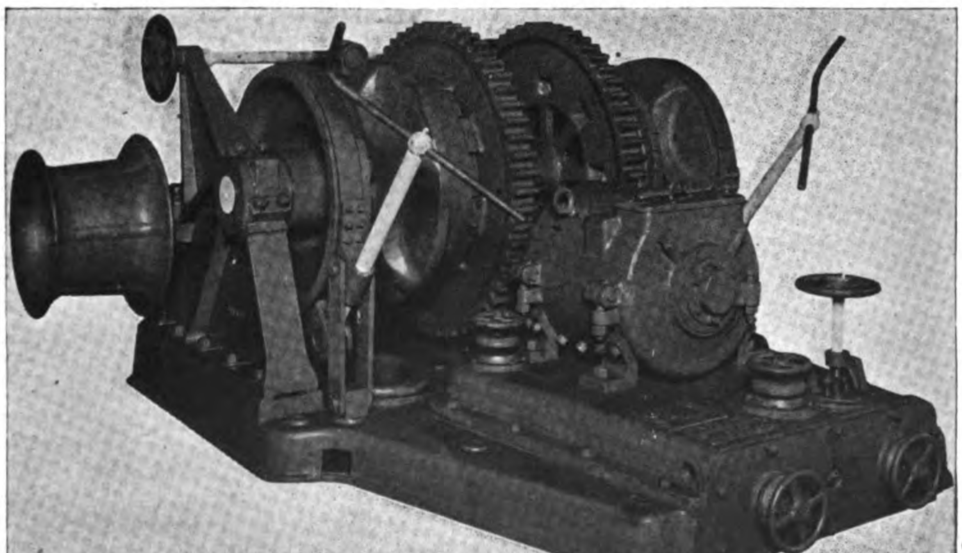
We refer to the Allan Cunningham Company, Inc. (late Pacific Machine Shop and Manufacturing Company), of Seattle, Washington. Among the motorships which they have equipped may be mentioned the "Benowa," which is a very interesting installation. She is one of six sister wooden motorships built at Seattle and propelled with two 640 i.h.p. McIntosh & Seymour-Diesel engines of the direct-reversible type, coupled direct to the propellers and designed to operate 165 r.p.m. She is of 4,400 tons d.w.c., and is 269 ft. long by 48 ft. breadth and 27 ft. depth.

We just stated that there are six sister wooden motorships to the "Benowa," but there really are ten wooden motorships of practically the same size, all propelled by McIntosh & Seymour Diesel engines. Four of these ships, the "Centhana," "Challambra," "Culburra," and "Coolcha," have steam auxiliaries, while the "Benowa," "Babinda," "Balcatta," "Boobyalla" and "Borrika," and one unnamed vessel, are equipped with electrical auxiliaries.

Shipowners should take particular note that the steam auxiliary machinery consumes about one-third of the total daily fuel-consumption of the ship. On the other hand, the consumption of the Diesel-electric auxiliary machinery and of the main engines altogether only totals about 35 barrels per day, and the Diesel-electric auxiliary plant uses less than 1/14th of this amount. In the time of a shipping slump when a vessel may be idle in harbor for several weeks between voyages, such an economical port-consumption will be of the greatest importance.

No doubt the success of the motorship "Benowa" in operation is partly due to the efficient handling of her cargo by the electrical equipment installed on deck, and by the regular running of her electrical auxiliaries in the engine-room, as well as by the reliability of the twin propelling-engines. All pumps, air-compressors, anchor-windlasses, cargo-winches, capstans, steering-gear, syren, fans, etc., are driven by individual electric-motors of the enclosed, water-tight, ventilated or open types, according to the duty performed. All deck auxiliaries, such as the steering-gear, telemotor, as well as the main and auxiliary electric-generating units and the control switchboard were furnished by the firm in question.

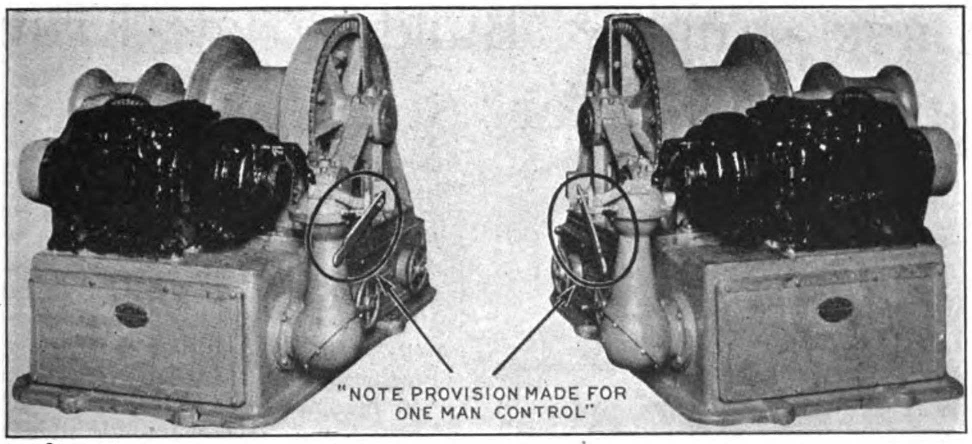
With the majority of motorships, high-speed type Diesel engines of the 4-cycle class are used for driving the electric-generators for auxiliary purposes, but in a number of instances surface-ignition type heavy-oil engines have been adopted. Possibly the surface-ignition type of oil-engine would have been used for this purpose on many more motorships, had all manufacturers of this class of engine given closer study to its application for this purpose, and had they designed self-contained sets which would better meet the requirements and conditions of service to be met with in engine-rooms of motorships; also if they had adopted better publicity with a view to getting their engines used for this purpose by shipowners and shipbuilders. Only a few manufacturers of the surface-ignition type of engine have done this.



Cunningham electric anchor windlass with water-tight motor controller and resister in hollow base

The motorship "Benowa" has a Fairbanks-Morse surface-ignition engine installed for this purpose, and the main generating-unit consists of a 60 kw, 125-volt, direct-current dynamo, coupled to a 75 b.h.p. surface-ignition oil-engine on a common bed-plate. It is designed to carry the total load of the electric motors operating when the ship is in port.

In addition to this, there is an auxiliary generating-unit consisting of a 30 kw. 125-volt dynamo coupled to a Fairbanks-Morse surface-ignition oil-engine, 37 b.h.p., of the same design as the 75 h.p. motor. This set drives



Two Cunningham electric cargo-winches. One operator can handle two winches

sufficient current for use when at sea. Both units are placed on a flat just after the main engines, and take fuel-oil from the same supply tanks, and exhaust into the same smoke-stack. Also located on this flat, directly behind the generating-units, is the main switchboard, and its position enables the engineer-on-watch to observe the performance under all conditions. It contains all the necessary instruments, protective and switching equipment, provides a very flexible means of transferring the load, and is a centralized control of all electrical circuits leading to various parts of the ship.

Other equipment on this flat includes two centrifugal circulating-water-pumps, each of a capacity of 417 gallons. Each is driven by a direct-connected electric-motor of 7½ b.h.p.

With further regard to pumps, the general-service pump is located on the outboard side of the port main engine, and is of the Goulds triplex-plunger type. It is driven by a 15 h.p. electric-motor through gearing, and has a capacity of 130 gallons per minute.

For fresh-water service there is a Goulds centrifugal-pump connected to a ¾-h.p. electric motor. A similar pump is installed for sanitary purposes, and also is driven by a ¾-h.p electric motor. Both of these pumps have 1½-in. suction and 1-in. discharge. There is a fuel-transfer pump of the vertical-triplex type, having a 30 gallons capacity and a 40-ft. head. It is driven by a 2 b.h.p. electric-motor. On the other side of the engine-room there is a general-pump which is practically a duplicate of the service-pump on the port side, and also is driven by a 15 b.h.p. electric motor.

Also located on the starboard side is the principal auxiliary air-compressor. This is a Rix 2-stage, 9-in. x 3½-in. x 6-in., of 75 cu. ft. capacity, and it is gear-driven from a 25 h.p. electric-motor. In connection with this air-compressor there is a Rix booster for the purpose of raising the pressure from 350 lbs. per square inch to 1000 lbs. It is driven by a 3 h.p. electric-motor.

This completes the electically-driven auxiliaries in the engine-room. Passing up to the poop-deck, there is a 11½-in. dia. barrel Cunningham electric-capstan arranged on both sides of the steering-gear-house. Each of these capstans is driven by a 10 b.h.p. water-tight electric-motor. The control equipment also is water-tight. While used essentially for warping, these capstans are so arranged that the relieving tackle may be passed quickly to the tiller on the steering-engine in an emergency. The steering-gear is of the right and left-hand screw type, with both emergency tiller and hand-gear. It is entirely electrically-driven and controlled. The bridge telemotor consists of control-stand with an operating-lever and helm-indicator.

For working the cargo-holds there are eight Cunningham electric-winches, four on the upper deck and the remainder on the main deck forward. Each winch is of the single-drum, direct-geared type, with the motor and resistor self-contained and properly water-tight. Control is arranged near the hatch coaming, in order that one man can handle two winches and at the same time can constantly see the sling. This has the advantage of doing away with a signal-man—except under extreme conditions—and tends to considerably speed up the handling of the cargo.

The electric-motors of these winches are fitted with a powerful mechanical holding-brake, that is released by an electric solenoid upon the application of current; but which will hold fast when the controller is moved to the "off" position, or upon the switching off of the current for any reason.

Because the ship will handle various classes of cargo, the normal rope-speed of the winches has been calculated at 150 ft. per minute with two tons on a single line, and is so arranged that lighter loads can be handled faster, and heavier loads correspondingly slower without change of gearing. As the winches automatically adapt themselves to all classes of cargo and loads within their rating, the high all-day efficiency is accounted for. This form of control can be applied to electric-winches of any size or rope-speed that up to the present time has been developed in steam. Furthermore, it can handle fast-moving ships with a far greater measure of safety.

Next we come to the anchor windlass. This is of a triple-geared, horizontal type arranged for a 1-15/16-in. stud-link chain, with two quick-warping ends on the intermediate shaft. Power is provided by a 25 b.h.p. water-tight electric-motor, control equipment of which also is water-tight.

Around the ship, below the above deck, there are numerous electrical appliances, such as fans, cabin-heaters, hot-water heaters, etc., for the comfort of the officers and crew. All these fittings add to our remarks regarding the very large field that there is for manufacturers of electrical appliances.

With further reference regarding our remarks regarding the economy obtained through electric auxiliaries, the makers of the Cunningham equipment advise us that repeated comparisons with both steam and electric auxiliaries as installed on these ten motorships, indicate that the fuel-consumption of the steam auxiliaries is at least ten times that of the electrical auxiliaries. We have even found the difference to be even greater as indicated in the first part of this article. Perusal of engineers' logs indicate that occasional attention to controller contacts, bearings and brushes is necessary with the electrical equipment, but no more adjustments or repairs are necessary than would be expected from the ordinary industrial installation on land. This in itself is a silent testimony of the reliability of properly designed electric auxiliaries aboard merchant motorships, and the correctness of their application for this purpose.

OIL-FUEL FOR AMERICAN SHIPS

If only the large amount of oil-fuel recently contracted for by the U. S. Shipping Board could be economically used in Diesel propelling-engines instead of wasted under the boilers of steamers, there is not the slightest doubt that the prices of this oil—together with the extra cargo-carrying capacities gained through its use—would enable American ships to successfully compete against the merchant vessels of all other nations. And the same quantity of fuel would last at least three times as long, and so avoid early depletion of the country's limited supply, incidentally reducing its future cost.

The following are some orders for oil-fuel recently placed by the Shipping Board:

From the Standard Oil Company of New Jersey

NEW YORK—9,300,000 barrels at $2.30 per barrel, terminal-delivery, and $2.40 per barrel, barge-delivery.

BALTIMORE—1,500,000 barrels at $2.27½ per barrel, terminal-delivery, and $2.37½ per barrel, barge-delivery.

NORFOLK—3,475,000 barrels at $2.60 per barrel, terminal-delivery, and $2.70 per barrel, barge-delivery.

CHARLESTON—400,000 barrels at $2.15 per barrel, terminal-delivery.

NEW ORLEANS—1,150,000 barrels at $1.90 per barrel, terminal (Baton Rouge) delivery, and $2.05 per barrel, barge-delivery.

From the Atlantic Refining Company, Philadelphia, Pa.

3,000,000 barrels of "?" grade fuel-oil at $2.30 per barrel, terminal-delivery, and $2.38½ per barrel, barge-delivery, Philadelphia, Pa., deliveries to be made during the calendar year 1921.

From the Gulf Refining Company, Pittsburgh, Pa.

125,000 barrels of "C" grade fuel-oil at $2.10 per barrel, terminal-delivery, and $2.20 per barrel, barge-delivery at Port Arthur, Texas, deliveries to be made over six months' period beginning October 1, 1920.

From the Midco-Mexico Company, Tulsa, Okla.

4,900,000 to 7,000,000 barrels of "C" grade fuel-oil at $1.10 per barrel, terminal-delivery, for the first year and $1.25 per barrel, terminal-delivery, for the next two succeeding years at New Orleans, deliveries to start on or about January 1, 1921.

The Shipping Board agrees to charter to the above bidders necessary tank-steamer transportation at the Government time charter rate of $6.50 per d.w.t. per month.

The bids of the following companies were rejected:

Mexican Petroleum Corporation, New York City, France & Canada Oil Transport Company and Swift Sure Oil Transport Company, Incorporated, New York City; Sun Company, Philadelphia, Pa.; Atlantic Refining Co., Philadelphia Pa., (Bid at Brunswick, Georgia); Atlantic Gulf Oil Corporation, New York City; Mexican Producing & Refining Company, New York City; Barber Asphalt Paving Company, Philadelphia, Pa.

MAIDEN VOYAGE OF MOTORSHIP "SALERNO"

With a full load of cargo, the new Dutch-built Norwegian 6500 tons d.w.c. motorship, "Salerno," reached Rio De Janeiro on her maiden voyage. Owing to an error on the part of one of the engineers in reading the telegraph, he ran the engine "full ahead" instead of astern when docking, and the ship hit the dock, badly damaging the stem. Temporary repairs were made with cement, and after discharging her cargo the "Salerno" reloaded and left for Kristiania where she recently arrived with the following cargo aboard:

Bananas	3,178 cases
Linseed	32,813 sacks
Maize	7,937 sacks
Flour	3,300 sacks
Rice	400 sacks
Cotton-seed flour	14,074 sacks
Coffee	1,676 sacks
Wax	12 sacks
Tobacco	21 bales

The above demonstrates the great *net* carrying-capacity of this motorship for her dimensions, namely, 375 ft. by 51 ft. by 34 ft., made possible by the short engine-room (less than 40 ft.), and absence of deep-tank on this long round voyage. The "Salerno" was fully described and illustrated in "Motorship" of June, 1920, and is propelled by twin Werkspoor Diesel engines aggregating 2,800 i.h.p. Her total daily fuel-consumption is sixty-three barrels (9 tons) and her loaded speed 11 knots. She is owned by the Otto & Thor. Thoresen Line, of Kristiania. It should be obvious to shipowners that there is no existing American *steamship* of about the same overall dimensions that could compete with the "Salerno."

Progress in Marine Diesel-Engine Building at Krupp's During the War

(Continued from page 696, August issue)

By OTTO ALT

Chief-Engineer, Oil-Engine Dep't, Krupp's Germania Works, Kiel, Germany

PART III.

Furthermore, it is very interesting that the temperatures in the walls of two-cycle cylinder-covers of submarine engines were less than those measured with four-cycle engines. Probably, this results from the lower mean indicated pressure and from the thinner walls of the two-cycle engines experimented upon.

It is certain that the danger of heat-cracking has been diminished by the experience and knowledge obtained up till now. It seems to be possible to select for each specific heat-load a design that will ensure sufficient durability.

Transformation of Energy

Often the opinion is to be met, that the transformation of energy in the oil-engine is improvable. It is thought that this can be obtained on the one hand by diminishing the excess of air, that means by increasing the mean pressure, on the other hand by diminishing the cooling and exhaust losses, that means by increasing the thermal-efficiency. With regard to the excess of air, there is a marked contrast between the Diesel-engine and the low-pressure engine, working with a fuel carburetor. With the former low fuel-consumption and complete combustion is obtained with an excess-of-air co-efficient equal to 1 or slightly more, whilst the Diesel oil-engine begins to smoke if the excess-of-air co-efficient is less than 1,4. Progress seems to lie in the direction of better atomizing and distributing the fuel in the combustion-chamber.

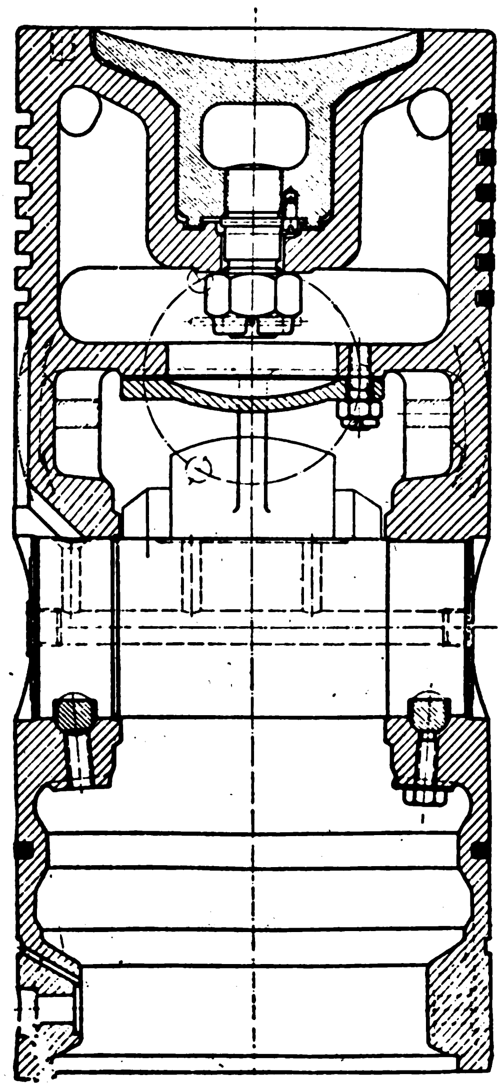


Fig. 15—Uncooled piston of the Germaniawerft construction

Concerning the *heat-losses by cooling* there is probably very little to gain. We learn from the researches made, that only a small quantity of heat flows into the cooling-water during the combustion and expansion periods. The chief part of the heat contained in the cooling-water is due to the exhaust gases. The only means to gain more energy are to diminish the exhaust losses. These losses can be reduced by accelerating the combustion. Theoretically the combustion in the Diesel oil-engine ought to be finished with the end of the injection. In the actual process and especially for engines having high-speed and high mean-pressure, burning on account of the limited velocity of ignition continues down to the exhaust period.

Figs. 16 and 17 represent the variations of temperature in the working cylinder from the beginning of the combustion to the exhaust. The second fig. shows distinctly how the slow combustion extends down to the exhaust period. It seems to be possible to effect an improvement by accelerating the combustion, but the gain cannot be considerable.

Certainly the quantity of heat, carried off with the cooling water and the exhaust gases, may be utilized. But it is well-known that only a small portion of the heat energy of the exhaust-gases can be transformed into mechanical or electrical energy.

Therefore, we have to admit that in the Diesel oil-engine there is hardly any chance left for a noticeable improvement in the utilization of the fuel-energy above the present highest value of 35%.

Increase of Power

In the preceding chapter we saw that it is impossible to increase the output of a given oil-engine without employing special means. Therefore, it is necessary to go other ways in order to obtain higher powers for short or long periods.

The most effective means for securing an increase of power is to increase the weight of the charge by filling-up the working cylinder with a greater quantity of air. Therefore, at first sight, the two-cycle engine seems to offer better chances for an increase of power than the four-cycle engine. This, however, is not the case. Overloading of the four-cycle engine can be brought about in a very simple manner by filling the cylinder with compressed-air during the suction stroke.

For investigating this system, the Germaniawerft has made several experiments with a stationary engine, obtaining remarkable results.

Figs. 18-21 represent some of the indicator diagrams obtained during these experimental trials showing mean indicated pressures of 14 kg. cm² (200 lb. sq. inch) and more. By this method the maximum power per cylinder of the four-cycle engine has been increased in a marked degree.

As it is at present possible to build perfectly reliable four-cycle engines of the single-acting trunk-piston type for submarines giving 6,000 shaft H.P. in twelve cylinders, *by increasing the power by the before mentioned method, we can obtain* 8,000 *shaft H.P. from the same engine set.* With two such engines combined with two 1,750 B.H.P. engines that work on the shafts by electric-transmission when cruising and otherwise are used for charging the battery, *it is possible to install a comparatively simple plant of about* 19,000 *shaft H.P.*

Furthermore the four-cycle engine by these means becomes the ideal cruising engine for different types of warships. Whilst cruising, one or two engines work with normal mean pressure and speed. If forcing the power plant of the warship is necessary the blowers for increasing the power of the oil engines, possibly driven by steam-turbines, are started, thus raising the speed of the oil-engine and of the propeller-shafts. By this increase of power the speed of the oil-engine can be adapted to the cruising and forced speeds of the propellers.

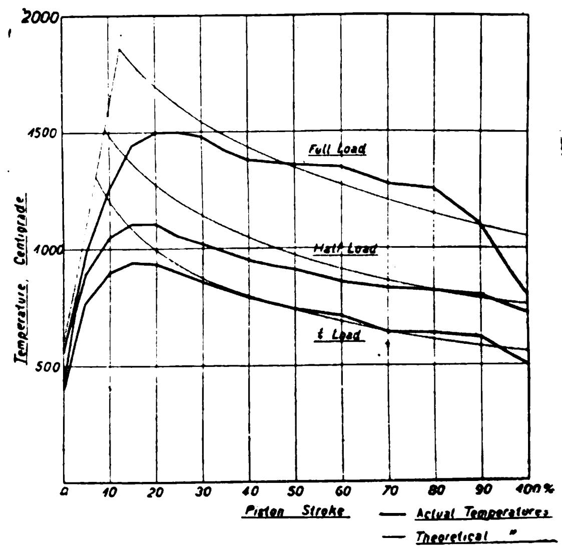


Fig. 16—Temperatures in the cylinder of 1700 b.h.p. four-cycle and 1650 b.h.p. two-cycle submarine engine during combustion and expansion calculated from indicator diagrams

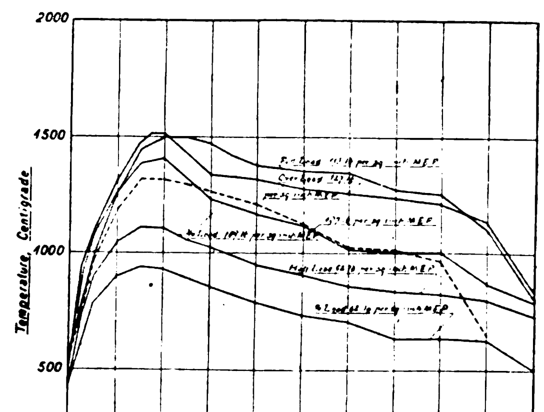


Fig. 17—Temperatures in the cylinder of 1700 b.h.p. four-cycle submarine engine during combustion and expansion calculated from actual and theoretical working pressures

Two or Four-cycle Engines?

At the beginning of the evolution of the marine-oil-engine and its adoption for the driving of submarines in the years of 1907-08, nearly everybody thought the two-cycle system the more effective system for ship propulsion.

How are matters now after 12 years' evolu-

tion? To my opinion the question: two-cycle or four-cycle cannot be answered conclusively at present because in the short time of the development of the two-cycle engine it was not possible to master all the difficulties.

Surely, if the well-known reaction against the two-cycle system had not taken place, the two-cycle engine would have developed in as quiet and steady a manner as the four-cycle engine. *It is certainly not right to condemn the two-cycle system wholesale.* There are certain purposes such as high-powered ships and locomotives for which the two-cycle engine will be necessary.

The Germaniawerft building all sorts of two and four-cycle engines for marine and stationary purposes for nearly 20 years past,

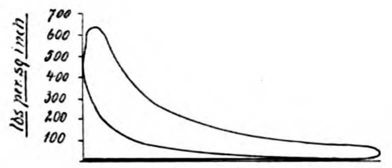


Fig. 18.

Fig. 19.

Fig. 20.

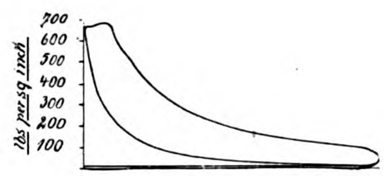


Fig. 21.

	Fig. 18	Fig. 19	Fig. 20	Fig. 21
Initial pressure lb. per sq. inch absolute	16.7	20.6	22.6	24.4
Injection pressure lb. per sq. inch absolute	870	885	885	885
Mean effective pressure lb. per sq. inch absolute	151	171	183	201
Number of revolutions	202	197	194	183

Figs. 18 to 21—Indicator diagrams from an engine working with increased power

may claim to be competent in oil-engine matters.

After having built two-cycle engines for many years which are the reasons for the Germaniawerft to prefer the four-cycle system at present? The decision was arrived at by considering the inherent drawbacks of the two-cycle system and the advantages of the four-cycle system.

In the following the difficulties in building high speed two-cycle engines, especially for submarines, are enumerated:

1. With scavenging-valves arranged in the cylinder-cover, the engine runs the risk of heat-cracking.
2. For engines with scavenging-ports long experience is necessary in order to obtain an efficient scavenging of the cylinders. Probably for each type of engine special experiments will be necessary to secure the power wanted.
3. Owing to the greater specific-heat load of the two-cycle engine the risk of heat-cracking is higher. Special means for cooling, such as mentioned above, must be employed.
4. Even with telescopic-pipes arranged entirely outside the crank-pit, trouble may arise from water coming into the lubricating-oil by leakages and corrosion of the piston-cooling pipes. For the design of reliable engines the adoption of oil-cooling therefore, seems to be imperative. For high-powered two-cycle engines, however, the possibility of oil-cooling the pistons still must be proved.
5. In two-cycle engines as a rule a water-tight joint between the cylinder-liner and the scavenging and exhaust chamber of the cylinder is necessary. This means that the liner is held fast by the cylinder and therefore cannot expand freely. Seizing pistons are the consequence. For this reason two-cycle engines with cylinder bores from 400-450 mm. upwards must have crossheads.
6. In the two-cycle engine there is no reversal of the connecting-rod pressure, the bearings of the piston-pin, or in large engines of the cross-head receive pressure continually in one direction. Therefore it is very difficult to lubricate these bearings. For lubricating them after the method of Prof. Gümbel, special pumps have to be arranged, supplying lubricating oil under high pressure.

Which are the advantages of the high-speed four-cycle engine?

1. There is less risk of heat-cracking, the four-cycle engine having a smaller specific heat-load.
2. The scavenging of the cylinder is perfect. Without employing special methods, higher mean-pressures can be attained. Scavenging-pumps with their numerous valves and their noise are not necessary.
3. For cooling the pistons lubricating-oil can be used; therefore, no cooling-water can get into the oil.
4. The cylinder-liner of the four-cycle engine is perfectly free to expand and thus the risk of piston seizing is minimized. Therefore, four-cycle engines of much greater cylinder bores can be built without crossheads. At the present time specialists consider the bore of 650-700 mm. as a limit for the high speed four-cycle engine without crosshead.
5. Four-cycle engines can be driven at a higher speed than two-cycle engines of equal power. This is important for submarines as the weight of the electric machinery on this account will be lower for the four-cycle set.
6. The speed of the camshaft is only half that of the crankshaft, while in two-cycle engines the camshaft revolves at the same speed as the engine. Consequently the four-cycle valve-gear makes less noise and the timing of the fuel-valve is more exact.
7. The space required and of late also the weight are less. This is proved by fig. 22, which shows the installation of two 1,450 B.H.P. oil-engines in a submarine of 1,000 tons displacement. The length of the four-cycle engine is 6,672 mm., whilst that of the two-cycle engine is 7,050 mm., that means nearly 400 mm. greater. Moreover, there is less space left between two-cycle engines owing to the scavenging-pumps and the scavenging-air pipes.

   Both engines are designed for the highest speeds and mean-pressures admissible in the respective systems. The weight of the four-cycle engine is about 25,000 kg. (17,5 kg. per B.H.P.), that of the two-cycle engine about 28,500 kg. (19,5 kg. per B.H.P.) Investigations by the author have shown that for still larger plants the superiority of the four-cycle is still more marked as the two-cycle engine for large powers is only reliable when built with crossheads.
8. The fuel-consumption is 10% to 20% lower than that of the two-cycle engine. A low fuel-consumption of the two-cycle engine may be obtained, as it is well-known; but only by using a low piston-speed and a high mean-pressure. High mean-pressures are dangerous, and demand specially designed cylinders and cylinder-covers, also a very efficient-cooling. Therefore, these engines are very expensive.

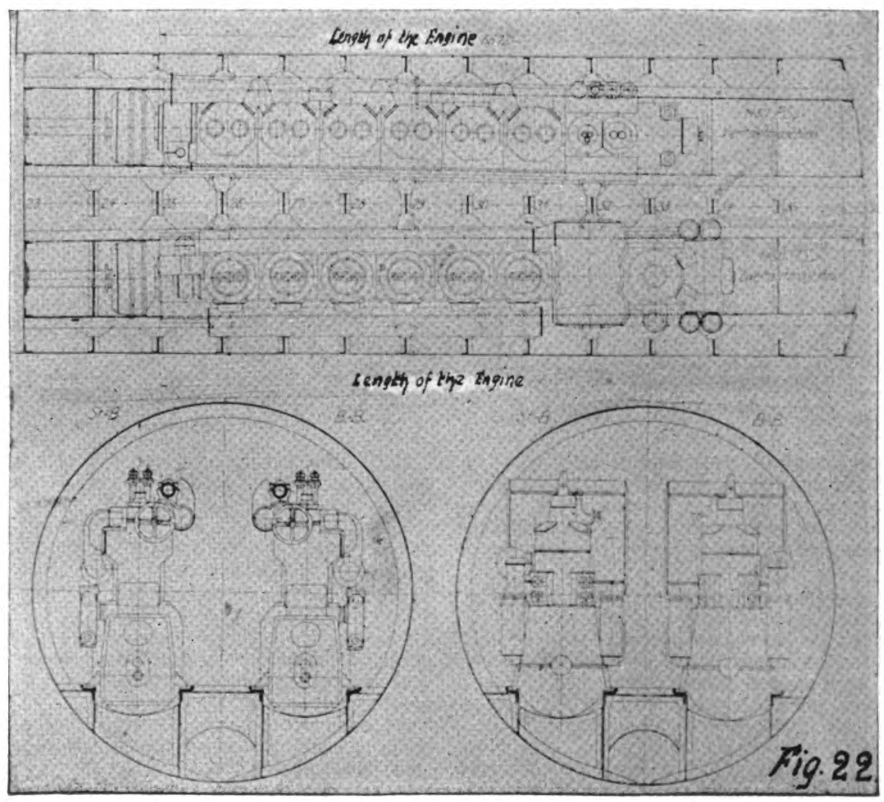


Fig. 22—Engine-room plan of a submarine with installations of 2 x 1450 b.h.p. two-cycle and four-cycle

It may be mentioned that for oil-engines for merchant vessels the superiority of the four-cycle type is disputed. The author reserves the discussion of this matter for a reply to the article: "SULZER TWO-CYCLE-ENGINES AND THE PROPULSION OF CARGO BOATS," published in the "Motorship" of March and April, 1920.

Conclusion

Of late several cheaper engines, such as hot-bulb surface-ignition engines and other so-called "semi-Diesel"-engines have come to the front as competitors of the Diesel oil-engine. Up to about 500 B.H.P. the field for marine engines is contested to the Diesel oil-engine by these rivals. Owing, however, to its ability for long uninterrupted running and its better utilization of the fuel, the consumption being 30% lower, the superiority of the Diesel oil-engine is undoubtable at present. Furthermore the Diesel oil-engine is the only internal-combustion engine for burning tar-oil fuel.

In future Diesel oil-engine builders will have to face some new and difficult problems. Among these, the problem of the Diesel locomotive takes the first place. The high fuel-efficiency of the Diesel-engine compared with that of the locomotive steam-engine is so striking, that the Diesel-locomotive will come to the front in spite of all technical difficulties.

There are three possibilities for the construction of Diesel-locomotives:

1. The Diesel-locomotive fitted with electric, hydraulic or pneumatic-transmission of the whole power.

2. The Diesel-locomotive fitted with mechanical gearing for the main part of the power and with electric, hydraulic or pneumatic transmission of a small part of the power in order to facilitate starting up.

3. The Diesel-locomotive fitted with mechanical gearing for the whole power.

For the first, however, all these propositions will have to be examined in all directions.

A second task for the designer is the construction of high-speed engines for motor-trucks and motor-ploughs. The chief difficulties with these engines arise from the necessary high speed, also from the fuel-pump and the fuel injection. In my opinion the chief competition will be between the low-pressure engine burning heavy oils and working with electric-ignition, and the compressorless Diesel oil-engine of the Steinbecker type.

The third task, the solution of which is being endeavored by designers is the construction of a high-powered heavy-oil engine for air-craft. Besides the difficulties above mentioned, the reduction of weight is a new condition to be fulfilled here.

Thus we see that the problems connected with the Diesel oil-engine will give work to the engine-builders of all the world, for many years to come.

OTTO ALT.

Air-Injection for High-Pressure Oil-Engines

(*Continued from page 711—August Issue*)

By J. L. CHALONER

(Part III)

The fuel used was American gas-oil of approximately 0.871 specific gravity, but unfortunately no further data were taken. However, diagrams for each condition of injection-pressure were recorded and are shown in Figs. No. 23 to 28 for Table No. 4.

The load was applied by the ordinary rope-brake, and the reduction in the horse-power during the trial was entirely due to the speed dropping off as a result of the decreasing injection-air pressure. The results clearly show the most favorable injection-pressure, and incidentally point to the fact, that a constant pressure-line on the indicator during the combustion period is not essential to give the desired degree of combustion.

In table the same observations were made at a lower load. Figs. No. 29 to 34 refer to the values tabulated in Table No. 5.

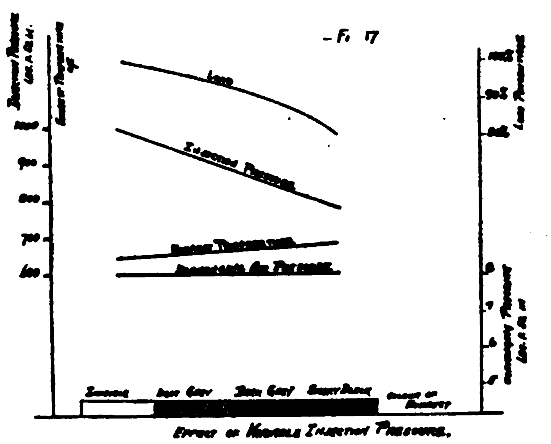
In table No. 6 the injection-pressure has been kept constant, while the load is varied from about half-load to well over full-load. Although no comments are made on the degree of combustion, the recorded figures make it quite clear to what extent the injection-air pressure may remain constant without showing its effect on the running of the engine.

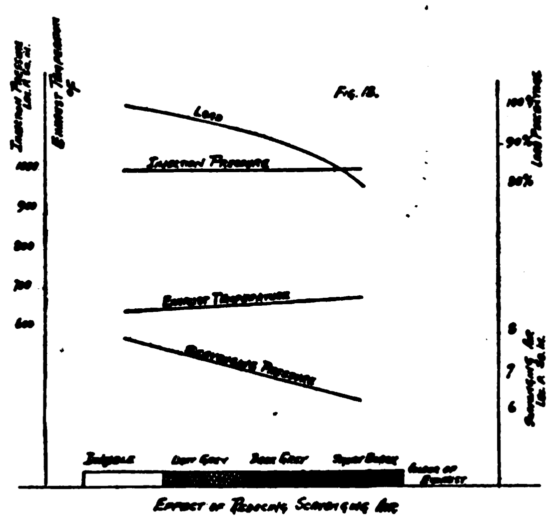
All engines were of the vertical type with the exception of the engine fitted with the open nozzle, which was of the horizontal type.

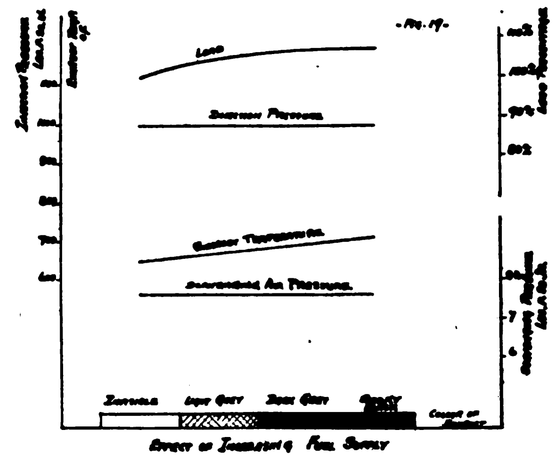
better distribution of the fuel over the combustion chamber apart from any turbulence effect, which might be brought into play. Yet the air/oil ratio is very much higher, the designer probably having in view the high speed at which the engine is running.

In the many tables quoted above, it will have been noticed that repeated reference has been made to the air excess co-efficient. It is thought that some remarks would be appropriate at this stage to make engineers fully acquainted with the determination of this factor. It is well-known that during any combustion process maybe in the boiler furnace, maybe in the combustion space of an oil-engine, the air supply, according to theoretical deductions, is not sufficient to give the desired degree of combustion.

A supply, therefore, in excess of this theoretical supply must be provided and the actual quantity can be measured quite readily from an examina-







In order to complete the records of the ratio of fuel to injection-air, a number of four-stroke engines of varying power have been selected. Each of these engines has been submitted to tests during which the quantity of the injection air has been determined.

The diagrams are rather interesting from the point of view of mean-effective pressures. At full load the respective pressures for the highest and lowest injection-pressure differ considerable from the remaining mean-effective-pressures which to all intents and purposes are constant. At half-load the greatest difference in the mean-effective-pressure is at the lowest value of the injection-pressure. It is rather unfortunate that for the half-load test the decrease of the injection-air pressure was not carried below the 750 lbs. per square inch. This pressure is that recommended by the makers as the most suitable one, and it would certainly have been rather interesting to see the effect of a blast, which is considered too low from a general point of efficiency.

It will now be interesting to study the effect of keeping the injection-air constant and varying the load, and for the resulting conditions it will be necessary to refer again to the experiments carried out by Munziger on the 15 H.P. heavy-oil engine.

The table brings out very clearly that the injection-air is not used purely for atomizing purposes, but possesses the additional function of creating turbulence in the cylinder. It is suggested that the air/oil ratio is not a very definite indication of the action of the injection-air, without taking into consideration the pressure of the air inside the fuel-valve casing.

Obviously a volume of air subjected to a pressure of 1,000 lbs. and then suddenly released to 480 lbs. will create a greater disturbing effect than air expanded over a shorter range of pressures. Furthermore, the speed of the engine has an important bearing on the time available for combustion; the shorter the time the more effective must be the blast as an injection agent. The above table should give considerable assistance to designers, and it brings out valuable information of the part the compressed-air is made to play according to the various views embodied in the respective designs.

It is clear that the amount of air required for this type of engine is not as large as has been anticipated. It is not clear what the predominating effect is of the compressed air: Atomization or turbulence. In this connection attention is drawn to the engine fitted with two fuel-valves. Such an arrangement tends undoubtedly towards

tion of the exhaust gas analysis. The Orsat or some other similar CO_2 recorder is well known to the marine engineer for the flue gases, and the identical method is available for the exhaust-gases from the oil-engine. It is found that the air excess for satisfactory combustion under a boiler is greater than inside an internal-combustion engine, but the method for arriving at the actual value of this co-efficient is the same.

For complete combustion the resultant constituents of the exhaust gases are:

Carbon di-oxide, Water, Oxygen and Nitrogen.

The degree of incompleteness of combustion is measured by the percentage of carbon monoxide, and in the case of complete combustion the maximum possible percentage of carbon di-oxide is 21 per cent (by volume). In the case of fuels containing hygrogen, the nitrogen in the exhaust-gases increases with the hydrogen, because a part of the oxygen combines to water, which is not measured usually during the exhaust gas analysis.

From the nitrogen contents in the exhaust it is possible to determine the excess-co-efficient, which represent the number of times by which the actual air quantity exceeds the theoretical amount. It is, of course, obvious that with an increasing air excess there is a proportionate reduction of the carbon di-oxide contents.

Having determined the percentage of the nitrogen, oxygen, and carbon di-oxide present in the exhaust, the following formula will enable to calculate the excess air required for combustion. It is used as a check when the air quantities are

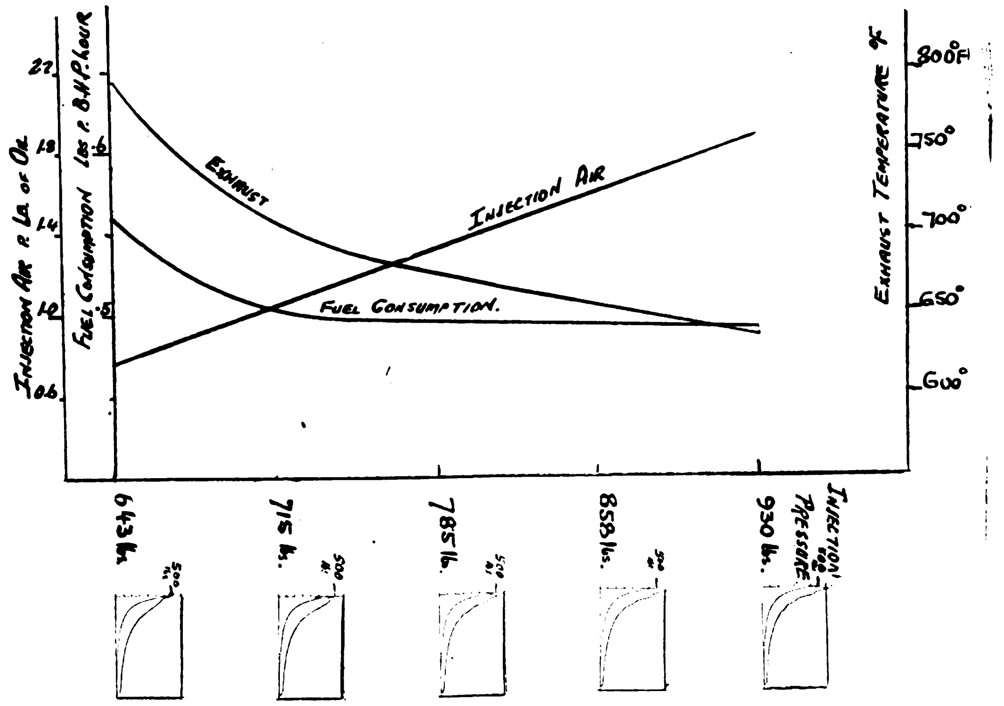


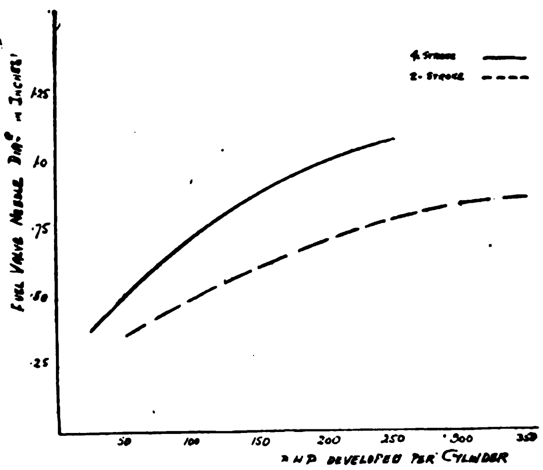
Fig. 20

measured directly as they enter the cylinder either through the suction-throttle of the air-pump, or the suction-air strainer of the engine.

$$\text{Excess Air Co-efficient} = \frac{209\ N}{209\ N-791\ (0-\frac{CO}{2})} \quad \ldots III.$$

where; N is the nitrogen in the exhaust-gases.
O is the oxygen in the exhaust-gases;
CO is the carbon monoxide (if any) in the exhaust-gases

It is suggested that the exhaust-gas recorder is a useful and simple means of checking the adjustments of the engine, and has the additional advantage of being already an old faithful servant



of the marine-engineer. It might be argued that the color of the exhaust is considered as a very simple, yet very effective, indication of the standard of combustion maintained inside the engine cylinder. In this connection it should be remembered that condensation and separation in the exhaust piping may easily change the general character of the exhaust-gases to such an extent as to produce erroneous impressions.

(3). *The relation between the injection-air and combustion.*

When dealing with the question of atomization, it is not a very easy matter to get a clear conception of the size of globule into which the charge of fuel-oil is split up by the compressed air. Some investigations bearing on this subject have resulted in the statement being made that with present modern design of fuel-valves for heavy-oil engines the injection is capable of producing oil globules having a diameter of 0.02 inches. This dimension hardly strikes one as very minute, and if such a size of globule is considered as the practical limit, it indicates that a stage of economical finality has been reached.

Let us examine for a moment one of the oil globules and it will become apparent that in order to attain efficient atomization, each particle of oil should be surrounded by a thin layer of injection-air. On the oil entering the combustion space, the heat of compression has to be transmitted to the oil-globule throught the layer of air. As the size of the globule decreases, *i.e.*, its volume, the ratio of the volume of oil and the volume of the encircling air decreases, hence the time for imparting a definite amount of heat to a definite amount of oil is greater.

This factor together with the cooling effect of the injection-air makes it apparent, that pulverization beyond a certain degree of fineness is not conducive to increased overall efficiency. This fact is of considerable importance in connection with rather viscous fuels, where higher injection-pressures have been recommended as advisable. Viscous oils are generally of lower calorific value, and in fact require more heat to burn them. From the above suggestion it would appear that under certain conditions atomization may retard the rate of combustion to an appreciable effect, at a moment when all the available heat in the combustion space should be imparted to the oil particles rather than to any other intervening agent.

The time element is of primary importance, and one of the disadvantages of the short injection period during the power stroke is the relatively high fuel-consumption of the high-pressure oil-engine as compared with the surface-ignition engine.

It will be noted from these reflections and the data, as recorded in the above tables, that the degree of combustion is only in part depending on the atomization, and that a certain amount of turbulence is necessary in the combustion space in order to produce that combustion as will produce the desirable fuel-consumption.

It is somewhat too previous to lay down definite rules as to what proportion of the combustion is to be regulated by the atomization, and what portion by the turbulence. It should be remem-

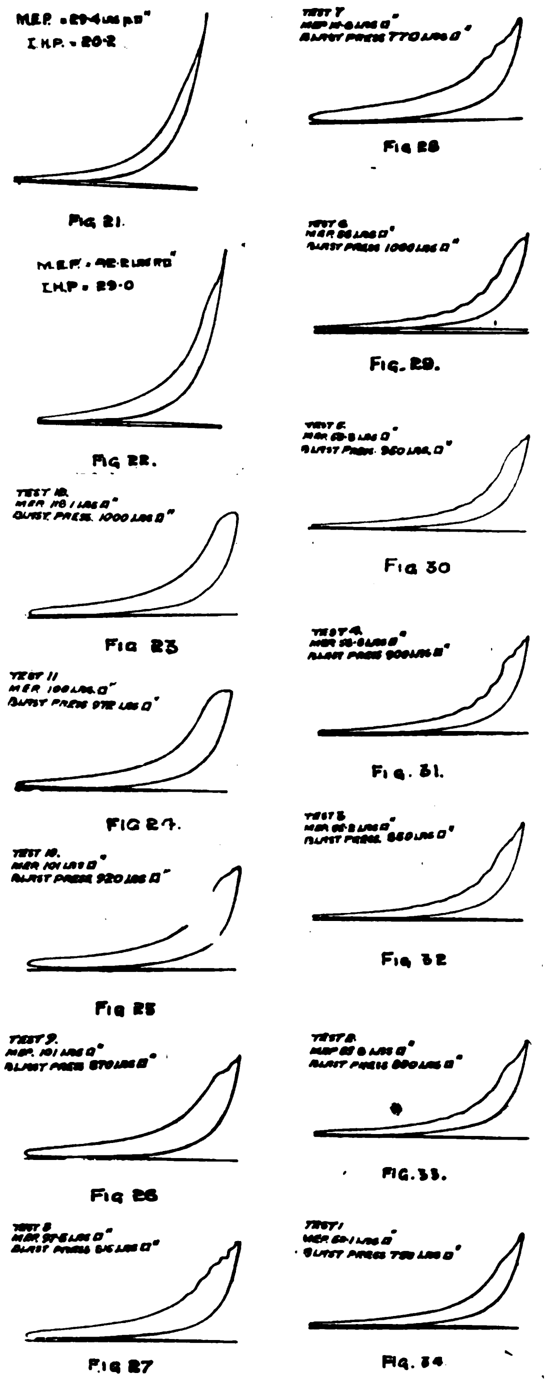


Fig. 21. Fig. 22. Fig. 23 Fig. 24. Fig. 25 Fig. 26 Fig. 27 Fig. 28 Fig. 29. Fig. 30 Fig. 31. Fig. 32 Fig. 33. Fig. 34

TABLE NO. 4

Horse Power	47.3	47.5	47.1	46.8	45.6	43.6	BHP.
Injection pressure	1000	972	920	870	815	770	Lbs.p.q.in
Cycle air	0.0826	0.0827	0.0826	0.0828	0.0828	0.0829	Lbs.p. cycle
Injection air	0.00665	0.00613	0.00525	0.00454	0.00374	0.00320	do
Fuel-Oil used	0.00308	0.00323	0.00325	0.00340	0.00375	0.00450	do
Excess air Co-efficient	1.51	1.52	1.43	1.35	1.13	0.92	
Exhaust temperature	902	862	931	952	1188	1215	Degrees F.
Speed	244	244	242	240	237	227	Revs.p.min.

TABLE NO. 5.

Horse power	20.7	20.7	20.6	20.5	20.6	20.7	BHP
Injection pressure	1000	950	900	850	800	750	Lbs.p.sq.in
Cycle Air	0.0832	0.0832	0.0831	0.0832	0.0831	0.0830	Lbs.p.cycle
Injection Air	0.0065	0.0057	0.0051	0.0042	0.0039	0.0031	do
Fuel-Oil used	0.00179	0.00178	0.00178	0.00176	0.00174	0.00172	do
Excess Air Co-efficient	2.97	2.96	2.93	2.95	2.97	2.98	
Exhaust temperature	572	573	574	574	583	583	Degrees F
Speed	254.0	254.0	255.0	254.5	254.5	254.5	R.P.M.

TABLE NO. 6.

Horse power	7.7	12.7	15.4	17.5	18.6	BHP
Injection pressure	858	858	858	858	858	Lbs.p.sq.in
Cycle Air	0.00950	0.00928	0.00920	0.00921	0.00922	Lbs.p.cycle
Injection Air	0.001555	0.001556	0.001568	0.001559	0.001546	do
Fuel-Oil used	0.000713	0.000945	0.001125	0.001386	0.001560	do
Excess Air Co-efficient	3.03	2.19	1.85	1.52	1.35	
Exhaust temperature	518	679	805	970	1044	Degree F.
Speed	236.5	236.0	232.2	228.2	229.0	Revs.p.min.

bered that at the present stage of the knowledge of the combustion process inside an oil-engine cylinder, it is impossible to establish any laws bearing on this point. The degree of atomization and turbulence are closely interwoven with the distribution of the fuel in the combustion space, the speed of flame propagation under certain pressures, temperatures and time limits, the formation and composition of any oil-gas during the partial dissociation up to the point of combustion, the spontaneous ignition-temperature of such gases, and any such other factors of which there is only a very superficial knowledge available.

Very little scientific research has been carried out, whereby it is possible to study the characteristics of compressed-air as an atomizer, and until this work is carried out, it will be impossible to get a concise notion of the atomizing process with air as the agent.

The air-injection method is so far the standard principle, and it will be wasted labor to discuss the merits and demerits of this system as against the mechanical-injection, until some further data are available as to the degree of atomization

TABLE NO. 7.

HORSE POWER p. cyl.	REVS.P. MIN.	BLAST PRESSURE lbs. sq. in.	CYCLE AIR lbs.	INJECTION AIR lbs.	FUEL USED lbs.	INJ. AIR OIL RATIO	EXHAUST TEMP. °F.
7.57	272	694	0.01376	0.000629	0.000416	1.50	465 (a)
15.6	235	858	0.00923	0.001576	0.001083	1.45	782 (a)
40.0	179	910	0.0782	0.00285	0.00236	1.22	1240 (a)
47.5	244	930	0.0827	0.00525	0.00325	1.62	877 (a)
80.0	168	925	0.165	0.00611	0.00644	1.39	1214 (a)
80.0	208	937	0.132	0.00467	0.00417	1.12	1387 (b)
180.0	216	955	0.2705	0.0097	0.00938	1.03	1438 (c)
200.0	167	960	0.423	0.0152	0.0151	1.00	1427 (c)
283.0	370	1215	0.256	0.0154	0.00591	2.60	932 (d)

(a) All engines ran on a petroleum oil.
(b) This engine is of the open injection-nozzle type.
(c) These engines ran on ar-oil without pilot-ignition.
(d) This engine has two fuel-valves for each cylinder.

which can be reached with modern designs of fuel-valves.

Some very remarkable results have been attained with mechanical-injection, and based on observation during the last few years it is suggested that the factor of turbulence is of greater importance than the degree of atomization, within reasonable limits, of course. However, it is hoped to revert to this point at some future time, when the subject of discussion is: Air-injection against mechanical-injection.

J. L. CHALONER.

Trials of the Motorship "Fullagar"

Sea trials of the welded-steel coastwise motorship, "Fullagar," of the Anchor Brocklebank Line, recently took place. This vessel is propelled by a 500 b.h.p. Cammellaird-Fullagar Diesel-engine of the opposed-piston two-cycle type and was built by Cammell Laird & Co. of Birkenhead, England. The engine turns at 100 to 120 r.p.m. On the river trials it was found that from full-speed ahead to full speed astern only required about ten seconds, the engine easy starting action with full ahead way on the ship.

At about 11:40 P. M. on June 29th, the vessel started on her maiden trip to the Clyde. After getting clear of land extremely rough weather was encountered; and as this became worse, it was found necessary to put into Ramsey until the storm abated. During this part of the voyage the engine ran steadily throughout, no racing being experienced, and there was only a slight variation in the revolutions. The hull was well tested, and withstood perfectly the severe shocks and stresses experienced through the force of the waves.

The vessel left Ramsey at 4:20 A. M. on the 1st July, and reached Greenock about 6 P. M. The engine continued to run steadily at a speed of 106 r.p.m., the ship doing about 9.75 knots against wind and tide.

On the 2nd July, a large party of Clyde shipbuilders and engineers were present and witnessed trial runs on the mile and manoeuvring tests. All expressed satisfaction at the running of the engine and the promptitude and satisfactory manner in which orders from the bridge were executed.

The "Fullagar" left the Clyde at 11:30 P. M. the same day, and arrived in the Mersey at 8 P. M. on the 3rd July. The engine ran satisfactorily and without sign of trouble at an average speed of 107 r.p.m., the vessel averaging about ten knots. During this run the fuel consumption worked out at 2.1 tons per day of 24 hours.

Some of the readings from the engine were as follows:

Fuel consumption......0.42 lb. per shaft h.p. hour
Scavenge air pressure ....1¼ lb. per sq. in.
Circulating water pressure ......6.5 lb. per sq. in.
Lubricating oil pressure ....12 lb. per sq. in.
Blast air pressure ....1,000 lb. per sq. in.
Scavenge temperature ....50° F.
Circulating discharge temperature ....100° F.
Engine-room temperature .... 62° F.

As previously announced in "Motorship" a 5,000 tons d.w.c. motorship with the same design of Diesel engines is now under construction for the same owners at Cammell Laird's yard.

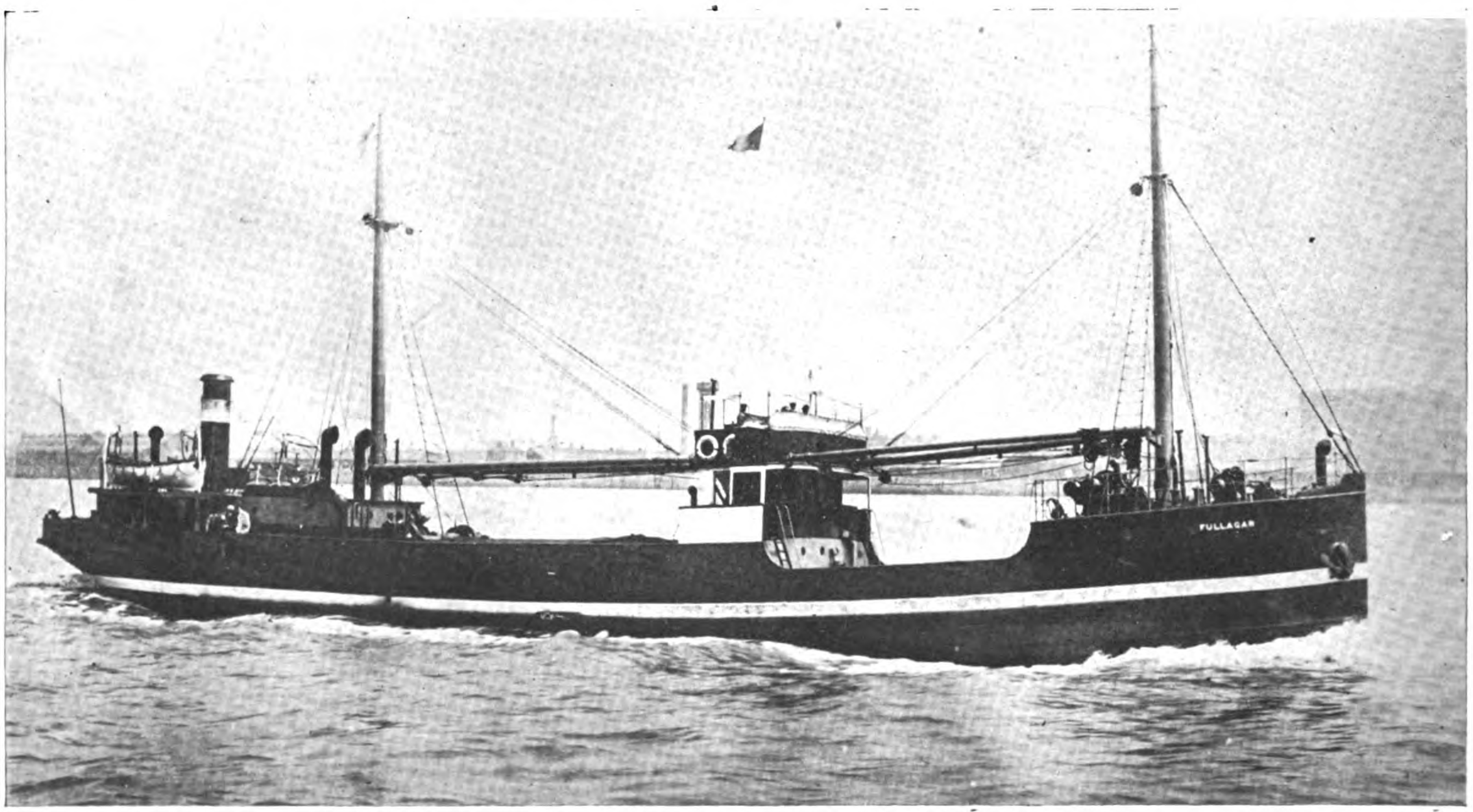
ELEVEN YEAR OLD WERKSPOOR-DIESEL AUXILIARY

Still engaged in trading between Dutch and African ports is the steel motor-auxiliary schooner "San Antonio," 400 tons d.w.c. This vessel was placed in service in 1909 and has given most constant service. She is propelled by a four-cylinder Werkspoor Diesel-engine of 200 shaft h.p. which drives a reversing propeller at 200 r.p.m. Average length of voyages is twelve months. The engine is used mostly in preference to sailing, and has never given any trouble, and the cost of upkeep has been extremely low. The pistons are drawn once a year for examination, and the compressor-valves about once in four months; exhaust-valves about once a month if convenient.

TEST OF NORTH-BRITISH DIESEL ENGINE

For the engine-room auxiliary machinery of the fleet of new motorships for the British India Steam Navigation Co. and for the Union Steamship Line of New Zealand, a new high-speed Diesel-engine has been designed by the North British Diesel Engine Co. of Glasgow. One of these—a six-cylinder 11½ in. by 14½ in. four-cycle model of 300 b.h.p. at 375 r.p.m. has completed a six-days non-stop run (as recently announced in our columns) coupled to a direct-current electric generator of 200 k.w. capacity.

The great importance of careful study of Diesel engines and electric equipment for the engine-room and deck auxiliaries of motorships will be realized when it is borne in mind that the Diesel-electric auxiliaries of each of these ships will total 1400 brake h.p., and with the two 2330 i.h.p. main propelling Diesel engines make the total power of each ship about 6000 horse-power. There are two 400 b.h.p. and two 300 b.h.p. auxiliary Diesel engines per ship, the former two driving air-compressors and the other two driving electric-generators. A test-report of one of these engines is given in this issue. The average fuel-consumption over the seven days was 0.309 lb. per Ind. h.p. hour, or 0.471 lb. per brake h.p. hour. The thermal-efficiency was 44.6%. Gargayle D.T.E. extra heavy oil was used for lubrication, while the fuel was Anglo-Persian oil 0.89 specific-gravity.



The British welded-steel motorship "Fullager" propelled by a 500 shaft h.p. Cammellaird Fullager Diesel engine. She is owned by the Anchor-Brocklebank Line who have the 5000 tons motorship "Mallia" under construction, which will have the same make of engines installed

SEVEN DAYS NON-STOP RUN

TEST-REPORT OF 300 B.H.P. NORTH BRITISH AUXILIARY DIESEL ENGINE

Card Marked		N Revs per Min Tachometer	Counter	Watch	W Brake Load in Lbs	Mean Pressure Cylinder I	II	III	IV	V	VI			Mean of M.E.P.	I.H.P.	B.H.P. W×N/600	Mechanical Efficiency	Pressure in Lbs/□" 1st Stage Air	2nd Stage	Injection Air	Starting Air	Circulating Water	Lubricating Oil
1		377·5		378	480	107·9	116·5	106·5	112·9	116	120·2	—	—	113·3	491·8	302	61·6%	61·5	215	925	1000	8·5	8
2		380	377	380	480	98	111	116·2	119	123·5	104·6	—	—	120·5	484·2	301·5	62·2%	70	215	925	—	8·5	9·5
3		375	377	378	480	107·8	127	112·5	124	104·3	85·5	—	—	110·3	472·4	301·5	63·9%	63	215	1050	—	8·5	10·5
4		378	376	376	480	92	116·7	111·9	113	109·1	102·5	—	—	107·5	461·7	301	65·5%	50	217·5	950	—	8·5	6
5		377·5	377·5	378	480	89·9	112·9	110·1	117	115·9	106·5	—	—	108·7	466·6	302	64·9%	57·5	220	970	—	9	5·5
6		380	377	378	480	75·1	110	111·9	112	103·3	125	—	—	106·2	455·3	301·5	66·2%	55	220	950	—	9	7
7		379	379	378	480	75·6	115·9	119·8	115·3	113·8	112	—	—	108·7	466·6	303·5	65·1%	50	217·5	975	—	9	5·5
8		376		375	480	87	116·7	113	118·4	111·5	101·5	—	—	108	460·2	300	65%	58	215	1070	—	8·5	7·5
9		378	378·5	376	480	88·9	116·7	103·5	118·5	113	108	—	—	108·1	464·7	303	65·2%	57·5	220	970	—	9	5·5
10		380	379	378	480	84·9	116·7	94·2	121·8	106·5	101·8	—	—	104·3	448	303·5	67·8%	55	220	950	—	9	7
11		380	379	378	480	73	116·7	103·2	118·2	108·8	100·2	—	—	104·2	448	303·5	67·8%	50	217·5	975	—	9	5·5
12		380	377	378	480	92·3	116·7	111·8	105·2	111·2	113·2	—	—	108·4	465	301·5	65%	51	212·5	1075	—	8·5	9
13		380	378	378	480	93·9	116·7	109·2	93·3	115·5	100	—	—	104·8	450	302·5	67·2%	53	212·5	1025	—	9	5·5
14		381	376	379	480	79	116·7	109	106	97·2	98·4	—	—	101·1	432	301	69·8%	47·5	215	1020	—	7	5
15		380	378	378	480	88·9	116·7	100·2	113·8	95·9	86·2	—	—	100·3	427·5	302·5	70·9%	50	215	1000	—	6	10

Card Marked	Temperature in Degrees F: Circulating Water Inlet	Outlet	Lubricating Oil Inlet	Outlet	Air Discharges 1st Stage Before Cooler	After Cooler	2nd Stage Before Cooler	After Cooler	3rd Stage Before Cooler	After Cooler	Exhaust at Engine	Crankcase	Atmosphere	Fuel Oil Lbs/Hour	Fuel Lbs per I.H.P. Hour	Fuel Lbs per B.H.P. Hour	Circulating Water Galls per I.H.P./Hour	I.H.P. Thermal Efficiency	B.H.P. Thermal Efficiency	Remarks
1	61·5	117	73	106	290	—	244	96	354	99	788	97	66	1468	·298	·487				Average Fuel Lbs per I.H.P.
2	57	112	72	105	298	—	248	96	340	96	746	95	65	1491	·314	·496				Hour = ·309
3	59	115	75·5	105	264	—	223	96	331	106	738	99	65	1383	·293	·456				
4	54	110	72	107	263	—	219	92	326	106	760	98	65	134	·290	·442				Average Fuel Lbs per B.H.P.
5	55	108	77	106	262	—	220	93	320	105	742	102	66	1492	·321	·495				Hour = ·471
6	54	107	75	108	262	—	219	89	324	105	762	89	66	1469	·322	·485				
7	53·5	106	75·5	109	258	—	218	90	327	112	743	99	67·5	1365	·294	·450				
8	52·5	105	73	105	265	—	222	88	331	118	758	100	62·5	132	·290	·440				
9	53	109	77	110	248	—	212	87	331	108	812	98	66	145	·313	·479				
10	53	105	78	106	254	—	214	86	324	105	780	98·5	66·5	143	·318	·472	23·2	44·6	29·4	
11	53	107	78	111	256	—	216	84	339	106	798	101	65·5	1485	·324	·430				
12	53	112	76	108	248	—	215	84·5	340	98	790	100	61	148	·319	·481				
13	52·5	112	74	107·5	251	—	213	85	336	99	802	99	62	1415	·315	·468				
14	53	118	76	108	252	—	216	83	333	100	736	99	63·5	1595	·322	·462				
15	53	120	76	110·5	248	—	213	83	329	97	788	99	63							

DESCRIPTION OF FUEL OIL USED:— ANGLO PERSIAN
SPECIFIC GRAVITY ·8900. FLASH POINT.
CALORIFIC VALUE TAKEN AT 18500 VISCOSITY.

DESCRIPTION OF LUBRICATING OIL:- GARGOYLE D. T. E. EXTRA HEAVY
SPECIFIC GRAVITY ·8901 FLASH POINT .
VISCOSITY

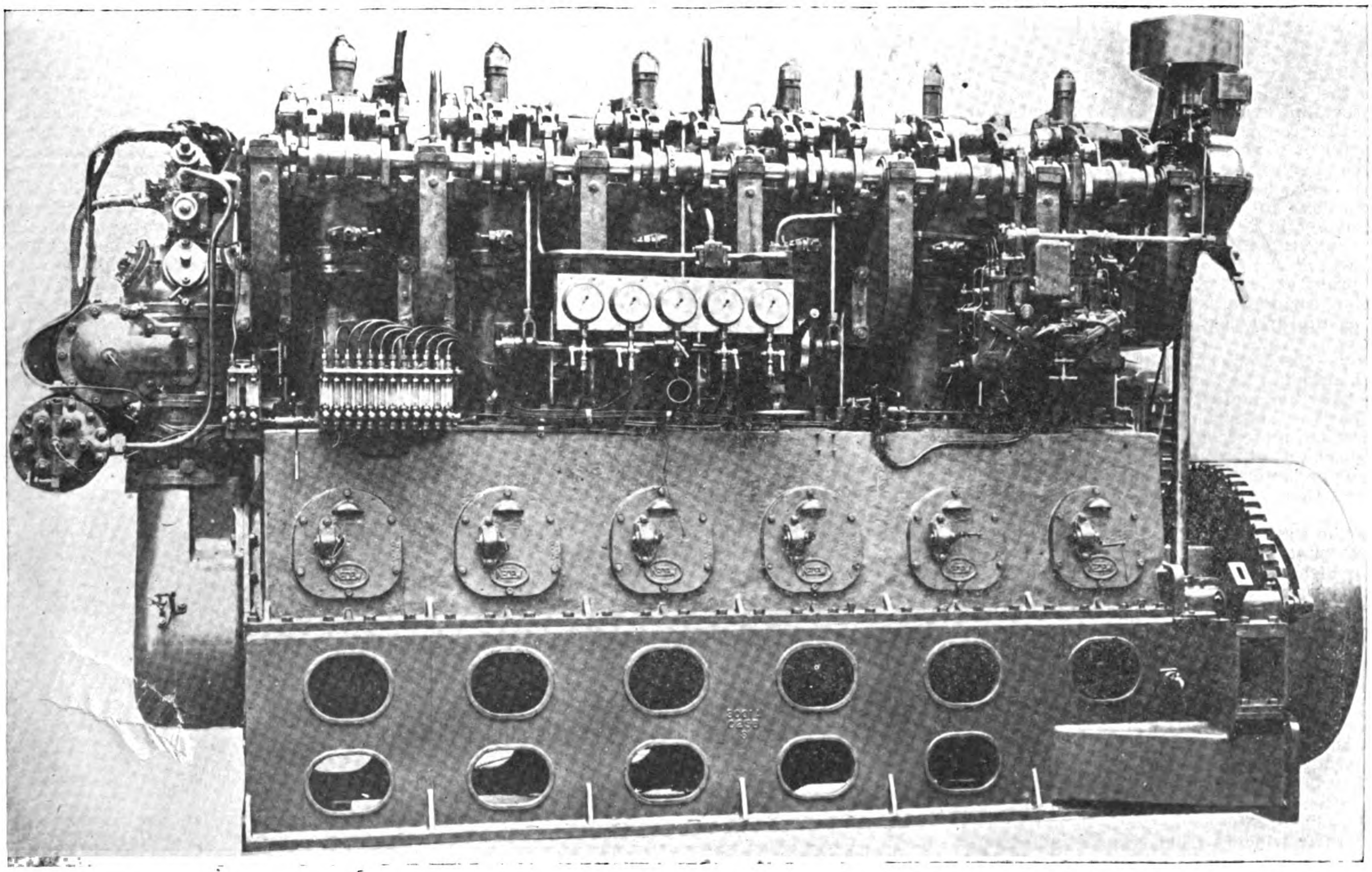
PARTICULARS OF ENGINE

TYPE:- SIX CYLINDER S.A. 4 CYCLE DES. Nº 201-B
BORE: 11·5 STROKE 14·5" REVS. 375
MAIN CYLDR. CLEARANCE. Nº1·345" Nº2=·404
Nº3=·389" Nº4·396" Nº5=·384 Nº6=·397
COMPRESSOR-H.P.(TOP)-·02" (TAPER)-·048"
M.P.(TAPER)-·066" L.P.(TOP)-·039"(TAPER) ·055
HORSE POWER CONSTANT ·189"

BAROMETRIC PRESSURE 29·81" (MEAN VALUE)

ADJUSTMENTS:-
FUEL CONTROL LEVER 9 NOTCHES OPEN

REMARKS— ENGINE DRIVES OWN AIR COMPRESSOR. FORCED LUBRICATION & WATER COOLING PUMPS DRIVEN INDEPENDENTLY. ENGINE SPEED CONTROLLED BY SENSITIVE GOVERNOR.



The 300 b.h.p. North British auxiliary Diesel-engine, one of a set generating electric-power in the engine room of one of the four large passenger motor-liners building for the British-India Steam Navigation Co.

Diesel Propulsion for Fruit Carriers

Two 3,300 Ton British Motorships Being Fitted with Beardmore-Tosi Diesel Engines

Followers of the development of the motorships are aware that the great majority of Diesel ships are fitted with twin screw machinery. However, at the present time the relative prices of oil and coal, and the arrangements for the distribution of liquid-fuel in Great Britain are such, that for vessels trading in British waters, or trading between Britain and the Continent, the Diesel system presents distinct advantages, and is now being applied to that most numerous class of single-screw cargo-carrier, the coaster, trading between England and adjacent ports, for which twin-screw machinery is not so applicable.

For well over a hundred years MacAndrews, Limited, of Laurence-Pountney Hill, London, E. C. England, have been connected with the Anglo-Spanish-Portuguese general fruit and wine shipping trade, and have now over 20 steamers in operation. Their success has largely been due to the progressive policy which they have always followed, and, as an instance of their engineering foresight, it might be stated that they were amongst the first shipowners in England to adopt superheated-steam in conjunction with triple-expansion engines, and were the pioneers in this respect for the class of vessel suitable to their trade.

The same policy has led them to take advantage of further engineering developments, and to apply the Diesel engine to the propulsion of their ships, and, they have building at the present time with William Beardmore & Co., Ltd., Naval Construction Works, Dalmuir, Scotland, two Diesel ships of the following dimensions, 240 ft. x 38 ft. with a load displacement of 3,300 tons, to be fitted with single-screw machinery of the "Beardmore-Tosi" Diesel type. Among the advantages of the Diesel engine in connection with the carriage of fruit or other cargoes likely to deteriorate with a rise of temperature, is the elimination of the stokehold and the radiation of heat therefrom to the holds, thereby ensuring the discharge of cargo in perfect condition. Quite an important saving in this respect is realized from the fitting of Diesel engines. The economical speed for this class of vessel is from 10 to 11 knots, which, in conjunction with the size of ship determined by considerations of the ports with which they trade, makes the single-screw arrangement of machinery greatly to be preferred in comparison with twin-screws.

The Diesel engine—say Wm. Beardmore & Co.—has now sufficiently developed to be confidently and safely applied as a single-screw unit. For this type of vessel, apart from the saving in running costs in the fuel bill which amounts to from 40 to 60% as compared with coal or oil fired steamers, there is, furthermore, the great advantage with the Diesel engine that there are no standby losses. The small quantity of fuel required (amounting to 4½ tons per day) for operation at full power with these ships is accommodated in one small cross bunker at the forward end of the engine room. Therefore, cargo, as already mentioned, is entirely isolated from the machinery space, and is not subject to any heat whatsoever.

Placing the machinery aft makes possible the division of the ship into two large holds readily accessible through three big hatches served by six electric-winches. The "Beardmore-Tosi" Diesel engine, with which these ships are to be fitted have each six working-cylinders of 24.4 in. diameter by 38.4 in. stroke, and running at 105 revs. per minute, will develop continuously over 1000 shaft h.p., giving the ship at sea a speed of about 10½ knots fully laden.

It cannot be said that the Diesel engine is a simple machine, since within its cylinders it converts the heat of combustion of the fuel directly into work, yet it is of great interest to note that the builders of these motorships point out that when it is considered that the Diesel engine takes the place of the boilers, engines, condensers, and auxiliaries required with the steam plant, the seeming complication of the oil-engine is negatived when the ease of operation is taken into consideration. This design, of engine, working on the well-known 4-stroke cycle principle, possesses a number of notable features.

In regard to the main parts of the engine, standard reciprocating marine-steam practice is followed so that the running parts are equally accessible. The engine is provided with piston and connecting-rods and guides as in the normal steam-engine so that no side thrusts occur on the cylinders themselves. Manoeuvring is as simple, if not more so than with a steam engine, and requires merely the rotation of one handwheel which is arranged to operate the fuel and air valves and reversing mechanism in their correct sequence.

As has been found essential with marine Diesel engines, forced lubrication is adopted throughout. In every way, adjustment, during running or overhaul, when required, can be carried out with the maximum facility.

Some of the special features of the "Beardmore-Tosi" engine are, the method of starting to minimize the quantity of compressed air required, the various features in the design of the parts concerned with the combustion to render cooling particularly even, so minimizing the heat stresses, the patent valve-gear operating the main cylinder-head valves lessens the difficulties hitherto experienced in connection with the maintenance of those valves, which deal with the exhaust gases from the main combustion cylinder. These are mentioned in passing as some of the features.

Quite frequently a considerable portion of the economy gained by the installation of Diesel engines is negatived by the wasteful method of driving auxiliaries through the agency of a steam donkey-boiler. With these fruit ships all the auxiliary machinery is driven by electric-motors deriving their current from Diesel-driven generators each of 50 kilowatts capacity installed in the engine room. For all normal duties one Diesel generator will serve to provide the current required, the other being a standby; no donkey-boiler whatever is provided.

These Diesel-driven auxiliary sets will utilize exactly the same fuel and except for reversibility follows the lines of the main propulsive equipment in their method of operation, and the engine-room staff is thereby relieved of the necessity of maintaining a hybrid installation. Uniformity of practice is, indeed, the keynote of the vessel, the principle being carried out as far as possible in the auxiliary equipment, for example, the motors and their starters are of like pattern, as also the pumps—thus reducing the amount of spare gear to be carried. Any heating which may be required (and in this trade the necessity will be very infrequent) is legislated for by the installation of electric radiators.

From the brief description given, it will be realized and admitted that these two vessels will do much to promote the adoption of the Diesel engine in the great field of the smaller type of cargo-carrier, where the latest results of engineering and scientific development towards operating efficiency should be applied on a bold scale.

Efficiency in Electric-Winch Design

A New Winch of the Load Brake Type

By Sv. FASTING, Member A. S. M. E.

Competition has always made it necessary to increase the efficiency of a business to a point where prevailing market prices will leave a suitable profit for the capital invested. This may not be so much of a problem when the field can be considered as within a country, where the general conditions may be considered fairly alike, but where we have to compete with the rest of the world, notably in the merchant-marine field, we have to bring the efficiency of operating ships to a point where the prevailing freight rates may leave a profit at least as large as that made by our foreign competitors, whose laws, labor costs, as well as the first cost of ships are all in their favor.

We have observed how the different leading European shipping nations have turned their shipbuilding program more and more to motorships; the efficiency of this type of ship being so high that it makes it the most economical in service, and we certainly should sit-up and take notice, and even try "to go one better" in producing ships so highly economical that our earning power may exceed theirs.

One of the ways in which this can be done is by producing motorships with cargo-handling apparatus which can load and unload the vessels faster than current practice and if possible cost less in operation and so reduce the ship's time in port.

We have been the leaders of the world in hoisting and conveying apparatus for industrial purposes and there is no reason why this lead cannot be maintained in the marine field.

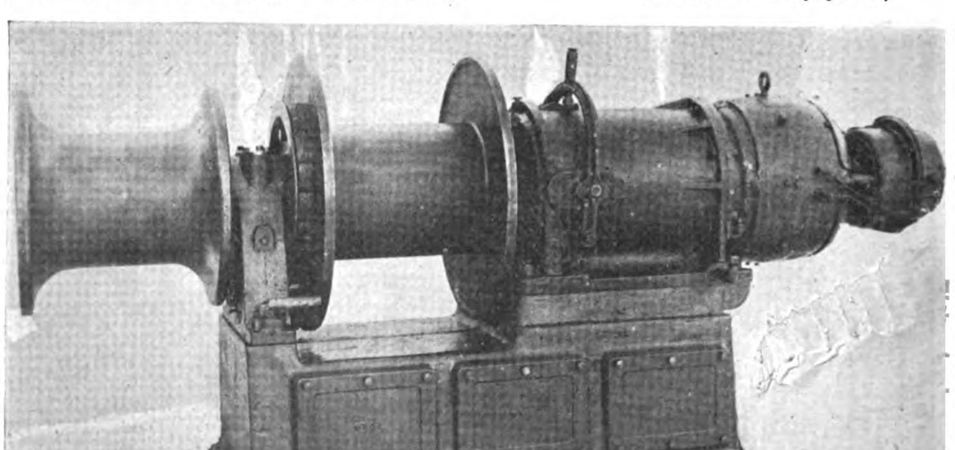
The first motorships were equipped with steam-winches, but this type of winch was soon discarded for the electric-driven type, which, especially for motorships, has a great many advantages.

As so often happens the steam-winch builders being already in the field, changed the driving power of their winches from steam to electricity, but in the main, retained the old mechanical details and arrangement of steam winch. With the assistance of the manufacturers of electrical apparatus they produced a workable, and what was considered an efficient winch, and the ease by which this change was made naturally appealed to the builder, whose experience in design of electrical hoisting machinery generally was very limited.

The winch developed in this manner was the winch with dynamic braking. This type of hoisting machinery may do very well in the industrial field, where the efficency of the hoisting apparatus is of secondary importance; the power consumed for this part of the work generally being a very small percentage of the total used in the plant. In the marine field where saving in the auxiliary generator units will have a direct effect on tonnage, as well as space for cargo, the efficiency becomes of paramount importance and it is here where the builder of hoisting machinery using a rugged, well-constructed type of mechanical load-brake should receive the most serious consideration.

It is true that many of the mechanical load-brake designs have been too weak in construction for severe duty, but when properly designed, they have been highly satisfactory. The mechanical brake as produced by the Shepard Electric Crane & Hoist Company of Montour Falls, N. Y., is a type which has proven itself of the highest degree of safety and efficiency, coupled with a minimum of wear in the heaviest kinds of service. These brakes are incorporated in a line of winches which

(*Continued on page* 15)



Shepard ship's cargo-winch arranged that drum may be held stationary while running the winch head

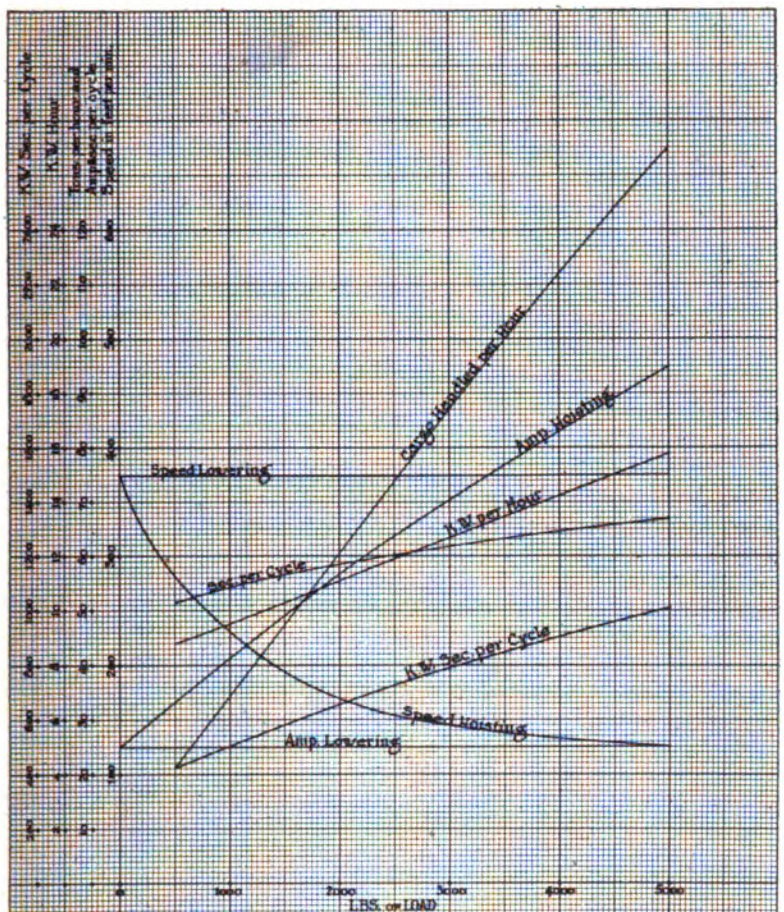


DIAGRAM FOR WINCHES WITH MECHANICAL BRAKING
MOTOR 25 HP - 550 R.P.M. - 55° C. RISE - 30 MIN.
DIAGRAM BASED ON 10 SEC. FOR ATTACHING AND 5 SEC DETACHING LOAD
CYCLE - 40 FT. LIFT - 38 FT. TRAVEL - 30 FT. LOWERING & RETURN.

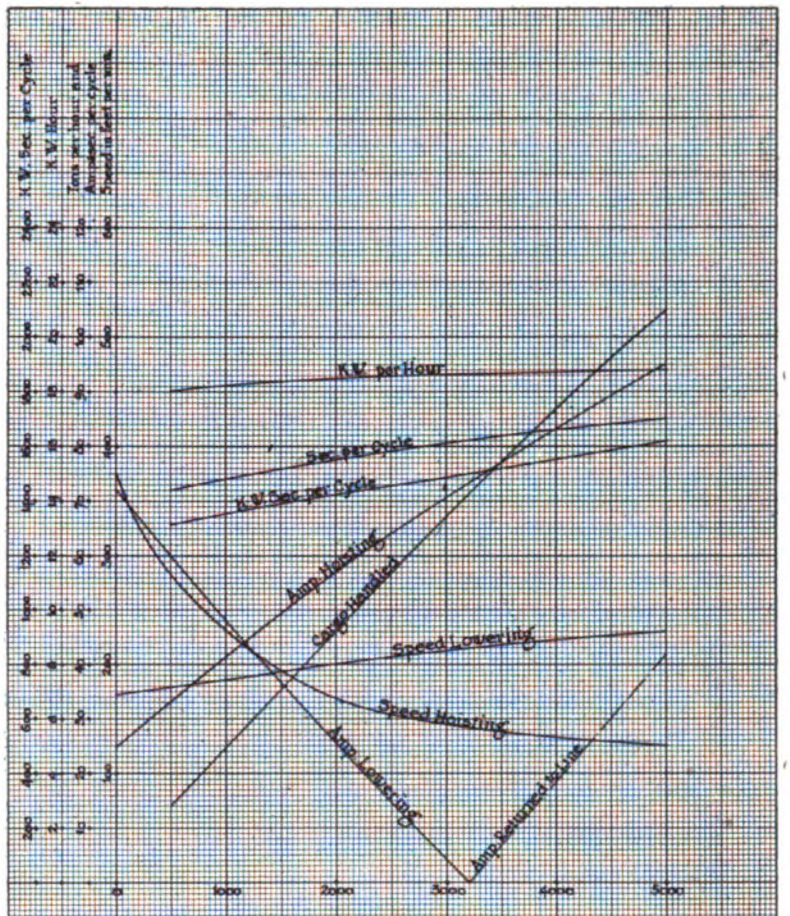


DIAGRAM FOR WINCHES WITH DYNAMIC BRAKING
MOTOR 25 HP - 550 R.P.M. - 55° C. RISE - 30 MIN.
DIAGRAM BASED ON 10 SEC FOR ATTACHING & 5 SEC DETACHING LOAD
CYCLE - 40 FEET LIFT - 38 FT. TRAVEL - 30 FT. LOWERING & RETURN

are marketed at the present time. These winches are constructed of the same details as used in their standard hoists and cranes and have the advantage for ship use, in that, they save about 30 per cent in current consumption and at the same time have an output of cargo handling work about 30 per cent in excess of the work done by the dynamic braking winch using the same size of motor.

The dynamic winches handle the light load and the empty hook at a relatively slow speed in lowering and will therefore slow up the possible speed of handling cargo. This is especially true when operating on a burtoning system which is the standard operation on board ships.

There is also a certain element of danger connected with the dynamic braking winch, which, however, may be disregarded if the winch operator at all times has a view of the load and does not depend upon a signal man for regulating the speeds. A characteristic of the dynamic braking which is, that, during lowering, should any one of the armature leads be disrupted through a break in the wire, a loose connection, a stuck or broken brush, the load will drop if the controller is not brought back to neutral, allowing the electric brake to set. This may cause trouble when working on signal, as during the time consumed in imparting and acting on the signal a load may drop a considerable distance. The mechanical braking winch will lower any load on the empty hook at the same speed, this lowering speed being the same as the hoisting speed with empty hook. This characteristic will be highly advantageous in attaining speed in handling of cargo on burtoning systems.

The two diagrams given show the relative values of winches with a standard type of dynamic braking and the winch equipped with the Shepard automatic mechanical load brake. These diagrams are made for the same motor and are based on two winches working together on a burtoning system. The cycle of operation is the same for either type and the time space between the cycles is the same. If we list the results given for full, three-quarter, half and one-quarter the rated load of the winch, we will get the following results.

The first cost of the mechanical braking winch may be somewhat higher than dynamic braking winches of the same horsepower, but when their low operating cost coupled with their high output of cargo handling work is being considered, true economy will be shown by their selection. The generator unit can be made smaller which will represent a direct saving in cost as well as give more space for cargo and an increase in the effective tonnage.

The general design of these winches embodies all of the construction details which have been found of great importance for operation in the industrial field and is the result of twenty years' experience in building high grade electrical hoisting apparatus.

The drum can be arranged with frictions which can be calibrated for a specific maximum pull, so as to guard against any excessive strains which may happen by rope getting fouled on hatch combings or hook being attached to loads heavier than the rated capacity of the winch. The winches can also be furnished with an arrangement so that the hoisting drum can be held stationary while winch-head can be run in the opposite direction from the hoisting direction of the drum. This feature will be valuable where rope-falls to the booms need to be handled by power as it will make it unnecessary to unreeve the rope from the drum.

LOADING	DYNAMIC BREAKING		MECHANICAL BRAKING	
Number 5000	105 tons per hour.	18.8 K. W hours.	135 tons per hour.	15.8 K. W. hours.
Number 3750	82 tons per hour.	18.7 K. W. hours.	105 tons per hour.	13.8 K. W. hours.
Number 2500	57 tons per hour.	18.6 K. W. hours.	74 tons per hour.	12. K. W. hours.
Number 1250	30 tons per hour.	18.3 K. W. hours.	41 tons per hour.	9.7 K. W. hours.

To get a direct comparison in per cent of power consumed and freight handled, we can consider the values for the dynamic braking winch as 100 per cent and the mechanical braking winch will then show up as follows:

Number 5000	freight handled hourly	129%	current consumed hourly 84%
Number 3750	freight hand'ed hourly	129%	current consumed hourly 74%
Number 2500	freight handled hourly	129%	current consumed hourly 65%
Number 1250	freight handled hourly	Number 136	current consumed hourly 53%

The lubrication is automatic in that the moving parts all run in a bath of oil and are equipped with oil reservoirs of large size guarding against any troubles occasioned by insufficient or, "forgotten" lubrication. Their efficiency and life is further insured by all enclosures and bearings being arranged so as to exclude any dust or grit from the outside or receiving other injury from exposure to rain and splashing of sea-water. Their thorough enclosures furthermore protect the operators and others receiving injury by moving gears and axles. All features of construction will show that the most thorough study has been given the subject before the product was placed on the market.

U. S. WAR DEPARTMENT'S SEVEN CONCRETE MOTORSHIPS

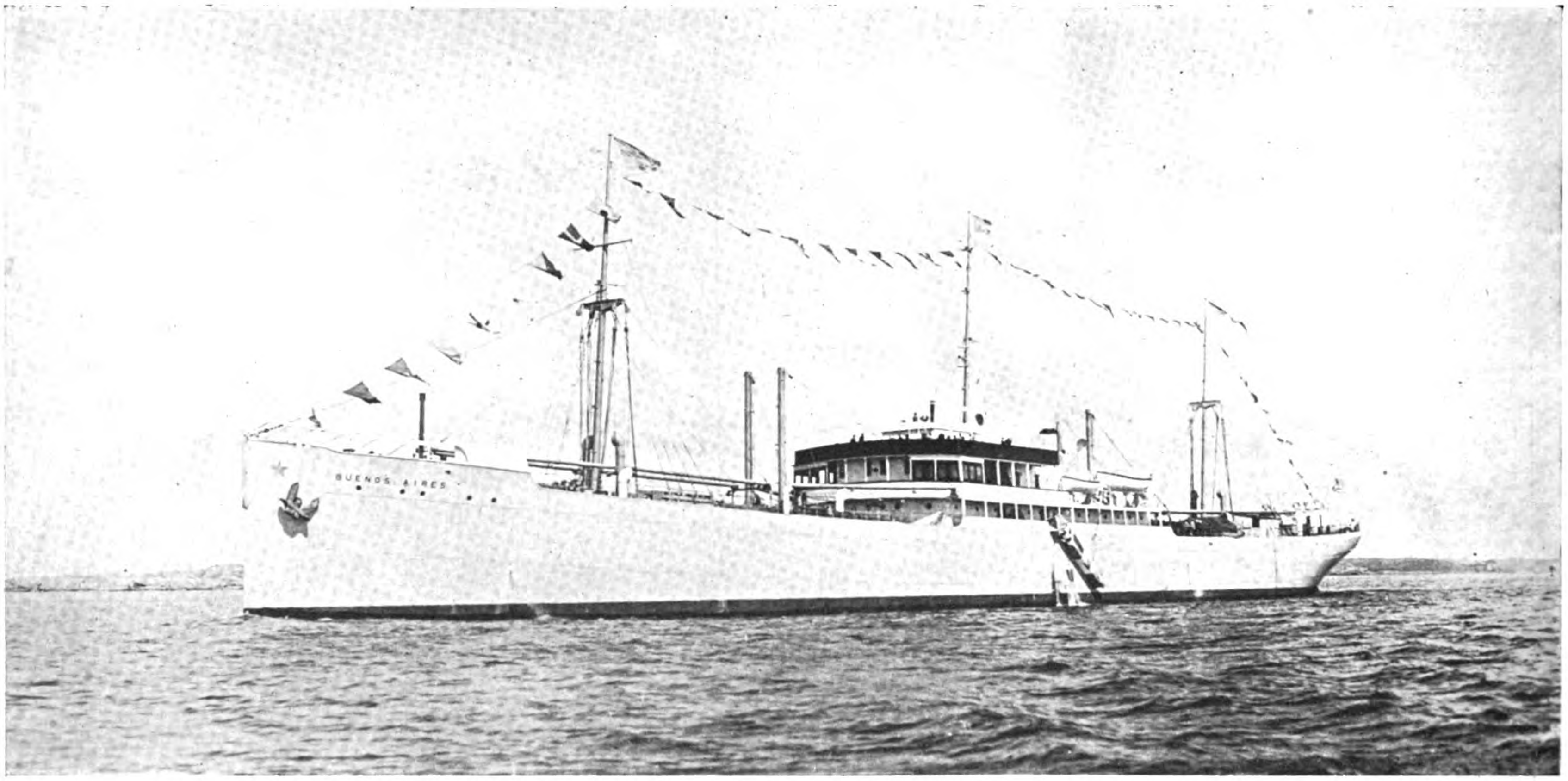
The seven small motorships referred to in our last issue as being built for the U. S. War Department will be constructed of concrete under the direction of Lieut. Col. Andersen. They are combination passenger and freight boats designed primarily for local fruit transport in connection with the U. S. Army. Each will have an oil-fuel bunker capacity of 45 tons. They are the largest concrete motor-vessels yet projected for the U. S. Government, but altogether about 35 concrete craft have been built under the supervision of Col. Andersen.

The boats have the following dimensions:

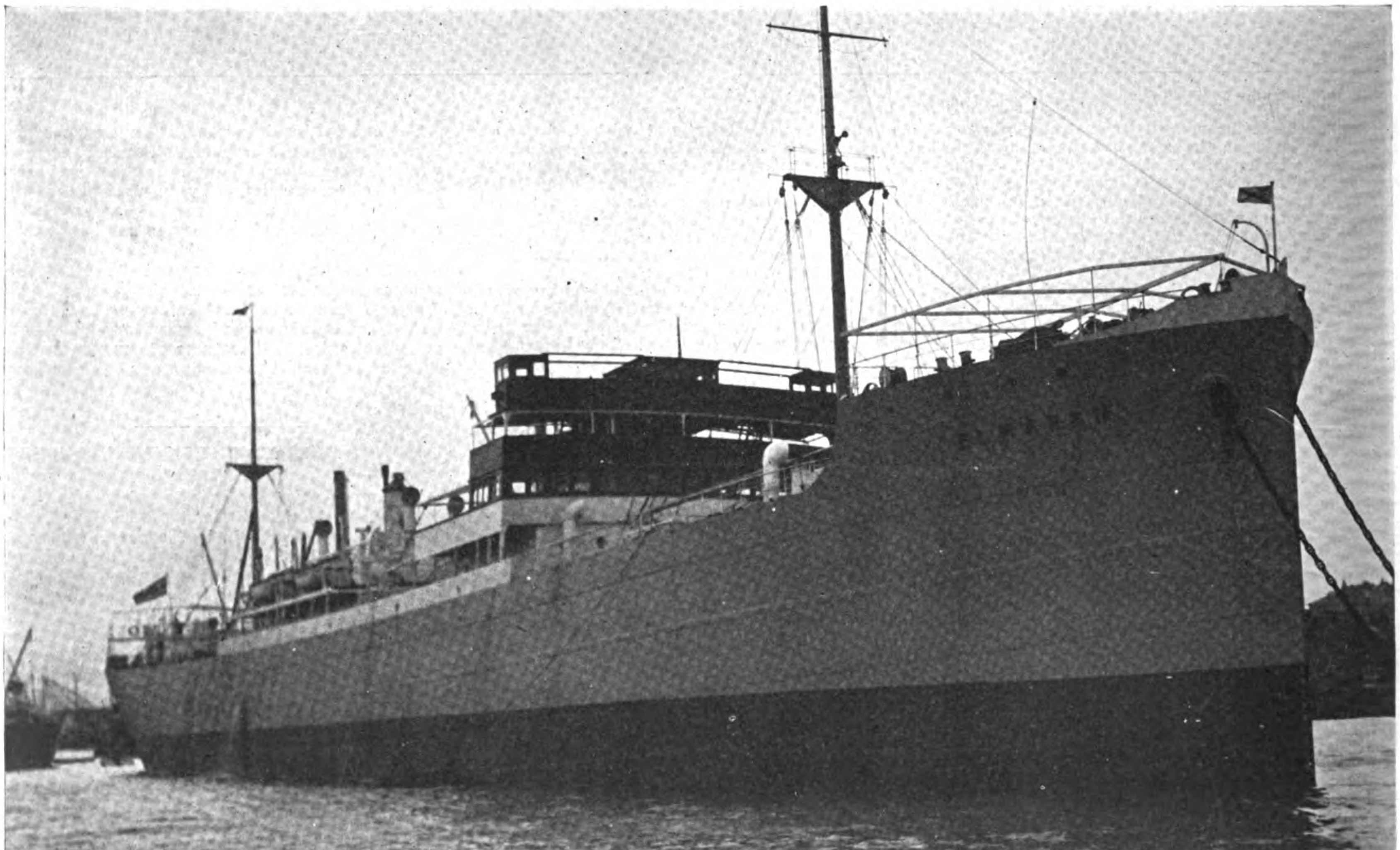
Length	150 ft.
Breadth	28 ft.
Moulded Depth	13 ft.
Power	900 shaft H.P.

Two Winton four-cycle type Diesel-engines are being fitted per boat, each engine having six cylinders 13 in. bore by 18 in. stroke. In addition there will be two three-cylinder 7½ in. by 11 in. Winton 50 b.h.p. Diesel engines driving electric generating-sets. For steam heating a small coal-burning boiler will be installed. Work on the craft will be commenced September 1st by the Newport Shipbuilding Company, Newport, N. C. and the first will be delivered about March 1st, 1921.

SWEDEN'S LATEST DIESEL-DRIVEN MOTORSHIPS



THE m. s. "BUENOS AIRES" 9300 TONS D.W.C.
Owned by the North Star S. S. Co. of Stockholm (Rederi. Nordstjernon), she left Göteborg on August 1 for South America with the owner, Consul-General Axel Johnson, and the Swedish Minister to Argentina on board. She was built and engined by the Götaverken of Göteborg, and is one of the finest motorships afloat



THE m. s. "ELMAREN" 9420 TONS D. W. C.
Her mean-speed on her recent trials was 13.11 knots developing 4126 i.h.p., and 13.96 knots maximum. She was built by the Götaverken of Göteborg and is now on her maiden voyage to Australia. She is owned by the Transatlantic Steamship Co. of Göteborg. Götaverken-built Burmeister & Wain Diesel-engines are installed

Ships with "THE MOST MODERN", "THE MOST EFFICIENT", and "THE MOST ECONOMICAL" Class of Machinery

Voyages of the Motorship "Katherine"

Successful Operation of an Iron Sailing-Ship After Conversion to Auxiliary Motor-Power

Last year the iron sailing-ship "Katherine," 2196 tons gross register built thirty-three years ago in Scotland, was converted into an auxiliary bald-headed schooner. Twin 320 shaft h.p. Bolinder surface-ignition oil-engines installed as the propelling units. She was fully described and illustrated in "Motorship" of December last. Since she started on her maiden voyage of 6987 nautical miles she has been very successful in service. When we described her we were not aware that practically all her engine-room auxiliary equipment was rebuilt second-hand machinery. Nevertheless, Chief Engineer F. Uhlein recently informed us that it has proven very reliable under the usual severe conditions of general service, as have the main engines which were new.

The owners of the "Katherine," the Philippine Vegetable Oil Company of New York, also own two other Bolinder oil-engined craft, namely the "Tankerville," propelled by twin 500 b.h.p. motors, and the "Nuianana," fitted with one 320 b.h.p. engine. The latter was their first boat, and the "Tankerville" the latest, so it will be noticed that they judicially increased the propulsion power with each successive vessel. It may be remembered we pointed-out in December that we considered the "Katherine" should have 1000 shaft h.p., but we since have learned that the owners could not wait while such large motors were being delivered, the 320 b.h.p. size being available in a much shorter time also this was the power advised by the engine-builders. She is a tanker and her total weight cargo-carrying capacity is 3000 tons on a 22 ft. draught.

Cargo is handled by steam-winches from an oil-fired donkey-boiler of 900 square feet heating-surface at 150 lbs. pressure.

EXTRACTS FROM M/S "KATHERINE'S" LOG BOOK

(Oct. 20th, 1919—May 1st, 1920)

Route, San Francisco to Manila; *Time*, 36d, 22 hr.; *Distance*, 6,987 naut. miles; *Aver. Speed*, 7.9 knots.

Remarks—Port engine full-speed during the entire trip. Starboard engine stopped 7 hrs. 10 minutes because of minor repairs on the compressor. No spares carried, otherwise repairs would not have amounted to more than one-half hour.

Route, Manila to Suez; *Time*, 37d. 22 hr.; *Distance*, 6,355 naut. miles; *Aver. Speed*, 7 knots.

Remarks—Weather unfavorable. Sails in use only four days. Both engines running at full-speed during the entire trip. Never missed a stroke. Strong head winds in Red Sea.

Route, Suez to Thames Haven, England; *Time*, 25d. 13 hr.; *Distance*, 3,579 naut. miles; *Aver. Speed*, 6.0 knots.

Remarks—Strong head-winds during one-third of distance. Both engines running at full speed during entire trip.

Route, Thames Haven to New York; *Time*, 30d. 4 hr.; *Distance*, 3,882 naut. miles; *Aver. Speed*, 5.8 knots.

Remarks—Strong head-winds and heavy sea. Sails used only one day. Port engines full-speed entire trip. Starboard engine stopped 20 minutes.

In a report to the engine-builders written from Balboa regarding the following voyage from New York to Panama, the Chief-Engineer said:

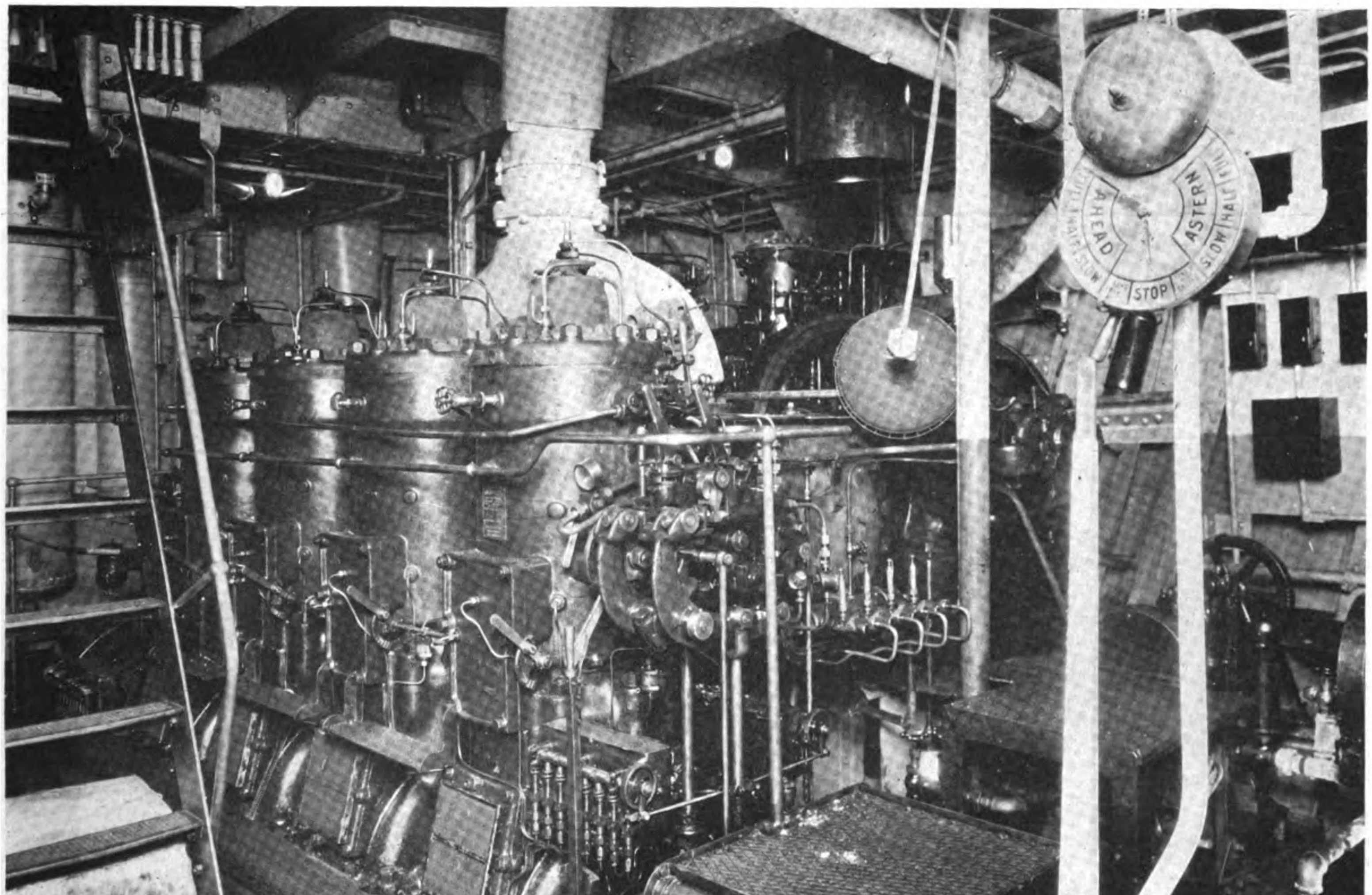
"I find the new propellers very much better than the old ones although a little too much pitch for best results. Engines were running 200 r.p.m. when sails were not in use, 210 to 218 with a fair wind. We made the trip in ten days, twelve hours. Engines at full-speed all the way and everything O.K. as usual. The first eight days we had a light head-wind, the rest of the trip a moderate breeze on the beam. The old propellers (Clubs) were 84 in. diameter, 51 in. pitch, new wheels 75 in. diameter, 66 in. pitch."

Although the "Katherine" carried 3000 tons of cargo, it will be noted that her moderate power of 740 shaft h.p. was used practically continuously, often driving the ship for 30 to 40 days without a stop and with only an occasional use of the sails. In other words, while designed as an auxiliary schooner, she has been operated as a full-powered motorship with auxiliary canvas.

It is remarkable that her oil-engines should have shown up so well under the severe work, and it speaks volumes for the reliability of the entire machinery, also for the watchful care and experience of her engine-room staff. The surface-ignition engines of the "Katherine" are as well made as any engine obtainable as a personal visit to the factory convinced us. But aboard some under-powered wooden auxiliary-schooners they have been badly installed and very carelessly operated under conditions far more severe than any steam-machinery could stand. In fact, they have suffered much undeserved abuse. Their steady operation in the "Katherine" indicates that under reasonable conditions they will stand-up to more than their share of work, especially if properly handled by conscientious engineers.

"DANEFOLK" A NEW 2200 TONS MOTOR AUXILIARY

A new steel-built motor-auxiliary schooner named "Danefolk" has been launched at the yard of the Rodby Shipbuilding Co., Denmark. She is propelled by two 160 b.h.p. heavy-oil engines. Her length is 242 ft. by 40 ft. breadth and 23 ft. 8 in. draught. She is owned by the Oceana Shipping Co. of Copenhagen, and is classed at Lloyds. The sister motorship "Danedronning" recently ran trials and was accepted.



Engine-room of motorship "Katherine" showing her pair of 320 b.h.p. Bolinder surface-ignition oil-engines

Interesting News and Notes from Everywhere

PRICE OF DIESEL-OIL IN PANAMA

Effective July 16th, the price of Diesel fuel-oil was advanced to $4.50 per barrel by private companies in the Panama Canal Zone.

Boiler Firm Building Motor Barges

J. & A. Niclausse, shipbuilders, Vilette-on-Sayne, France, launched the first of a series of 8 seagoing motor barges. This is of particular interest as they are marine boiler manufacturers.

ITALIAN SHIPOWNER PURCHASES TWO MOTORSHIPS

The Dutch motor schooner, "Vryenbain," has been purchased by Antonio Paolo Daraghiatti, of Durazzo, Italy,—also the twin-screw-producer gas-engine motorship, "Zeemeeuw," 229 tons gross.

"VIVIEN" A NEW NORWEGIAN MOTORSHIP

A steel motorship of 759 tons gross (about 1200 tons d.w.c.), named "Vivien" has been launched by the Marstal Steel Shipbuilding Co., of Marstal, Norway, to the order of Johnson & Kildahl A/S of Kristiania.

COPY OF JULY ISSUE OF "MOTORSHIP" WANTED

We are entirely sold out of the July, 1920, issue of "Motorship" so if any reader has a spare copy that he does not require we would be glad if he will mail the same with compliments to Mr. R. A. Watson, 7 Fieldside Road, Rock Ferry, Cheshire, England. This gentleman's copy was damaged en route and we are unable to send him another.

COAL-TAR OIL-FUEL IN GERMANY

Germany is now producing a considerable quantity of liquid fuel by the low-temperature distillation of coal and lignite says the "U. S. Commerce Reports." In the opinion of some of her leading engineers the fuel supply can best be developed by submitting the bulk of the coal to this low temperature distillation and using the oil so obtained in Diesel engines.

BIDS FOR SIX 2025 TONS SUBMARINES

On August 18, 1919, bids were opened by the U. S. Navy Department for six fleet-submarines. These vessels are to be Diesel-driven and will have a speed of 22 knots. Their surface-displacement is 2,025 tons, length is 300 ft. by 27 ft. 7 in. The lowest bid received was made by the Bethlehem Shipbuilding Corporation, who offered to build them all at $3,999,000 each. There were only two other bids, namely Electric Boat Company and the Lake Torpedo Boat Company.

However, the vessels which the Bethlehem Shipbuilding Corporation offered to build would only have a surface-displacement of 1,950 tons and a speed of 21 knots, whereas the Electric Boat Co.'s boats would be in accordance with the above specifications regarding size and speed. Their bid was $4,942,000 each. Altogether there are 9 fleet submarines to be built. The other three are to be constructed by the Navy Yard at Portsmouth, N. H.

"LYNETTEN" AND "ROSEN," TWO DANISH AUXILIARIES

Some time ago the Dragor Shipping Company of Copenhagen took delivery of the motor-auxiliary wooden sailing-ship "Rosen," of about 550 tons d.w.c. A sister vessel named the "Lynetten" has just been launched for the same owners by the Codan Shipbuilding Company at Koge. Her gross tonnage is 360, and an auxiliary oil-engine is installed.

MOTORSHIP FOR CHARGEURS RÉUNIS NOT TO BE ELECTRIC DRIVEN

We are informed by the Chargeurs Réunis, of Paris, that an order has been placed for a motorship, referred to on page 701 of our August issue, with Chantiers de La Loire, but that the engines will be direct-connected to the propellers without electric-transmissions. They will be Sulzer two-cycle type Diesels and we presume will be built under license, as the Chantiers de La Loire are Sulzer licensees.

LARGE MOTORSHIP ORDERED BY GRINDON STEAMSHIP COMPANY

An order for a Diesel-driven motorship of 12,750 tons displacement and 9350 tons d.w.c. has been placed with Messrs. Wm. Doxford & Sons, Ltd., of Sunderland, England, by the Grindon Steamship Co. (B. & J. Sutherland Co., Mgrs.), of Newcastle-on-Tyne). She will have a cubic-capacity of 571,000 cu. ft. in addition to a bunker-capacity of 1130 tons and 60 tons of fresh-water With this her cruising radius will be 33,500 nautical-miles. She will be propelled by a four-cylinder 3000 i.h.p. Doxford opposed-piston type heavy oil-engine turning at 70 r.p.m., which will give her a loaded speed of 10½ knots on a daily consumption of 9 tons of oil-fuel.

ANOTHER BIG BRITISH MOTORSHIP LAUNCHED.

On July 14th a large motorship was launched at the Govan yard of Harland & Wolf for the Glen Line. She is of 14,000 tons d.w.c. and is a sister to the motorship "Glenogle," which is now nearing her trial trip, and is 452 feet long b.p. by 62 feet breadth. The vessel is a combination cargo and passenger carrier, and is propelled by a twin-screw set of 4-cycle Diesel B. & W. type engines, developing a total of 6600 i.h.p. All the engine-room auxiliaries are electrically driven.

NEW BRITISH TWO-CYCLE ENGINED MOTORSHIP

The motorship which Alevander Stephen & Sons, Linthouse, Scotland, are building for the British India Navigation Co., Ltd., is of 10,000 tons d.w.c., and will have twin 1,600 shaft h.p. Stephen-Sulzer two-cycle Diesel engines installed.

BRITISH MOTORSHIP "INVERCORRIE"

The twin-screw motor-tanker "Palmol," 1144 tons gross, built for the British Admiralty has had her name changed to "Invercorrie." She was constructed by William Gray & Co., Ltd., of West Hartlepool, England, and is now owned by the British-Mexican Petroleum Company, Ltd. (Andrew Weir & Co.), of London. This vessel is 210 ft. long, by 34 ft. 6 in. breadth and 16 ft. 6 in. depth, and is propelled by two 4-cylinder 320 b.h.p. Bolinder oil-engines.

NEW GERMAN BOOK ON HIGH-SPEED DIESEL-ENGINES

"High Speed Diesel-Engines" is the title of a book that has just been brought out by Julius Springer, technical publishers, Berlin. It is a treatise on the development work done during the war on submarine-engines, and Diesel-engines suitable for auxiliaries or Diesel-electric generating-sets on board ships. This book has been written by Dr. Ing. Otto Föppl and Dr. Ing. H. Strombeck.

$1.50 PER BARREL PROFIT ON OIL

During the last fiscal year the Royal Dutch Petroleum Company produced 29,564,500 barrels of oil and made a net profit of $40,240,000.00 (at normal exchange rate). This is apart from the profits of £4,713,370 made by the connected company—the Shell Transport & Trading Co. in marketing and transporting this oil, part of which is included in the above, subsidiary companies of the Royal Dutch turned over $45,298,200.00 in dividends to the parent company.

NEARLY FIFTY PER CENT SAVING IN TRANSPORTATION COSTS

The Transatlantic Steamship Co. find that their Götaverken-built, Burmeister & Wain Diesel type 12½ knot 9400 tons motorships show a cost of transporting 1 ton of cargo a distance of 1000 sea-miles to be 24.60 kroners, compared with 42.40 kroners for their steamships. The cost of repairs of the East Asiatic Co.'s motorship fleet (15 vessels) during 8 years has only amounted to about 3½ million kroner, which compares very favorably with steamships. The present price of Danish-built B. & W. engines is about 600 kroner per I. H. P.

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

"OCEAN SHIPPING"

July 15, 1920.

To the Editor of "Motorship,"

Sir:

Regarding your comments on my book "Ocean Shipping" which you reviewed in your August issue, I did not, in this book attempt to go seriously into the matter of ship construction nor to comment regarding engines since these are quite out of my line. Except in the most rudimentary way, I confined my attention to the wharf, the office and the contract. In regard to turbines, Diesel engines and other types, I did not feel myself competent to express any opinion which would have value. In such matters we always go direct to competent engineers.

Yours very truly,

R. E. ANNIN.

c/o Sigsbee, Humphrey & Co.,
23 South William St.,
New York City.

["Motorship" did not expect the author to discuss the technical side of Diesel-engines in his book, but as a shipping man Mr. Annin should be familiar with the advantages gained in the way of fuel-consumption, extra cargo-Capacity, absence of firemen, etc., through the use of the Diesel type of machinery as a propulsive power. In fact, it is vitally important that every American shipowner makes himself thoroughly conversant with motorship operation as it is not possible for America to operate steamships in trans-ocean traffic in the face of European competition. To make his book complete and of real value to shipowner, the operating differences between the two types of vessels should at least have been outlined. We draw attention to Dr. Lucke's treatise on ship operation on other pages in this issue.—*Editor.*]

THE BOLNES ENGINE

June 28, 1920.

To the Editor of "Motorship,"

Sir:

I have read Mr. Joy's account of the "Bolnes" engine which I exhibited at Olympia, March 12-20. I cannot understand what he means when he says that *"The piston is no more accessible than in the ordinary type."*

One of the leading features of the open-type engine is the ease with which a piston can be removed, as in place of having to disconnect the crank-pin and removing piston with connecting-rod, in the "Bolnes" to remove the piston the engineer has only to disconnect the nut at the end of the piston-rod and draw the piston and rod. It is not necessary to touch either crank-pin or crosshead bearings as must be done in the case of the closed crank-case engine. The "Bolnes" engine has been built as an open-type engine since 1919.

Yours very truly,

ARTHUR R. BROWN.

54 New Broad St.,
London, E.C.2,
England.

FROM OUR FIRST ELECTRICAL PRODUCTS ADVERTISER

To the Editor of "Motorship,"

Sir:

When "Motorship" first started, this company was the only advertiser of electric winches and auxiliary machinery in your journal. We have noted with great interest the remarkable growth of your periodical to its present size, wherein practically all of the well-known manufacturers of marine machinery are advertisers.

We desire to take this opportunity of commending you on this showing, and assure you of our fullest co-operation in all matters pertaining to "Motorship."

Yours very truly,

ALLAN CUNNINGHAM CO., INC.,
(Successors to Pacific Machine Shop & Mfg. Co.)
Seattle, Wash.

ENGINEERS FOR MOTORSHIPS

To the Editor of "Motorship."

Sir:

I notice in your August issue, reference to motorship-engineers who had registered with you. I beg to advise you that I hold an unlimited Chief Engineer's license for motorships, and have been employed as Chief and as First-Assistant on board motor-vessels for the last three years.

Since returning from a voyage abroad, I have experienced difficulty in being placed on another ship, as there seems to be no demand for experienced marine Diesel-engineers.

Allow me to take the opportunity to congratulate you on the excellent work your magazine is doing. I am deeply interested in the future of the Diesel-engine, and have never seen any other publication that can compare with yours on the subject.

L. BEAHLEY.
c/o Ocean Marine
Engineer Beneficial Assoc.,
New York City.

Motorships vs Steamships

Comparative Operating Expenses and Earnings of Cargo Vessels

1. Method of Treatment.
2. Comparative Cargo Capacities of Motorships and Steamships of 10,000 Tons D. W. C.
3. Earnings and Expenses.
4. Cost of Cargo Transportation; Net Earnings and Investment Returns.

BY CHARLES E. LUCKE

Professor Mechanical Engineering, Columbia University, and Consulting Engineer, Worthington Pump and Machinery Corporation.

1. *Method of Treatment.*

Cargo motorships in overseas service have been steadily growing in numbers for several years, and at an increasing rate, and this fact alone is proof of successful competition with steamers. The performance of these motor freighters has established beyond question the very superior fuel economy of the internal-combustion over the steam type of propelling machinery, without any loss whatever in reliability when the oil-engines are of good modern design.

For all ocean freight service, motorships must now be considered in commercial competition with steamships, on quite the same terms as one type of steam freighter with another. The competition for a given size and speed of ship is reduced to a comparison of freight earnings, typical of one class of propelling machinery with reference to another. Earnings are measured by cargo-capacity and freight-rates on the one hand, and on the other by operating costs per trip or per mile.

Comparing cargo-capacities of two vessels of equal size and speed, but with different machinery, a difference in capacity is found for steam vessels, as in the case of steam-turbines compared with steam reciprocating-engines. The geared-turbine invariably permits of greater cargo capacity both for deadweight cargo and measurement cargo, (more or less than forty cubic-feet per ton), but the amount of the difference naturally depends on the design of the reciprocating-engines, the turbines, the boilers and the auxiliary machinery. The situation is quite the same in nature when the cargo-capacity of motorships as a class, is compared with that of steamships as a class, and while in this case the motorship usually permits of greater cargo-capacity than steamships, the amount of the difference depends on the design of the machinery being compared.

General figures of comparative cargo-capacities of motorships as a class, with reference to steamships as a class, are useful for preliminary estimates, but are not at all satisfactory or conclusive in a final analysis of the probable earnings of a given ship over a selected trade route. Commercial conclusions can be based only on careful calculations with actual or estimated values for each of the items entering into the total.

This requires an analysis of the total deadweight of the ship and the evaluation of all of the items, except cargo. The cargo weight is determined by subtracting the sum of these items from the total deadweight capacity of the ship. These deadweight items include the weights of (a) machinery; (b) fuel in bunkers; (c) water; (d) crew and effects; (e) stores—including food and spare gear. For comparative estimates it is sufficient to evaluate only those items that differ by a constant weight; as for example, machinery weights for motorship over steamship, and minor items such as crew and effects may be ignored entirely, because difference between them, in comparing two ships is of no consequence.

To evaluate the weight of fuel to be carried in bunkers requires a definite assumption of the length of voyage, and a decision as to where and when refueling is to be done, in addition to fixing the fuel-consumption per day at sea and in port. It is clear that a ship carrying fuel for a round trip on a long voyage will have less cargo-capacity outbound than returning, and the difference will be equalized only if bunkers are filled at each end. The most complicated case is that in which the ship makes a stop at many ports and fills bunkers at all, or at a few of them.

These are matters of ship operating management rather than type of machinery, but with the widely differing fuel-consumption per day for motorship vs. steamship, the question of relative suitability of one or the other for a given trade route at once arises, and the route factor may become the deciding one. In general, a long route with fuel in bunkers for the round trip is the condition most favorable to the motorship as a cargo carrier.

Comparative figures on ship-operating expenses per day, per voyage or per year, for two or more ships differing only in their machinery, are not only quite as necessary as the comparison of their cargo capacities, for a conclusion as to the commercial merits of one over the other, but much more important. When motorships are compared with steamships on this expense basis, much greater differences are found than in the matter of cargo capacity, and these expense differences are always very much in favor of the motorship if fixed or investment charges are ignored. They are also in favor of the motorship even when including the fixed charges if the vessel is worked hard enough, that is, kept at sea instead of being held in port.

Fixed or investment charges are annual constant expenses, and their value per mile or per voyage naturally is less as the miles per voyage or per year made by the vessel, is greater. Motorship machinery always costs more than steamship machinery per horsepower, therefore, investment charges against operation are always against the motorship. The importance of this item in the list of expenses becomes less as the operating expenses for labor and consumable supplies become larger, and the more the ship is worked the more the cost of consumed supplies, including fuel, controls the total.

This operating expense is always in favor of the motorship, mainly because of its very low fuel-consumption, so it is clear that whether the total cost of operating the ship (made up of fixed charges and operating expenses), will always favor the motorship or not, will depend on the relative size of the two items—one always in favor and the other always against the motorship; the former and favorable item being larger and the latter unfavorable item smaller, as the ship is kept at sea the more days per year. To reach a decision on these costs, it is necessary to prepare an itemized statement and calculate or estimate the value of each item, including:

(a) interest on investment;
(b) depreciation, including obsolescence;
(c) insurance;
(d) maintenance;
(e) loss and damage;
(f) fuel;
(g) water;
(h) crew wage and subsistence;
(i) stores;
(j) port charges;
(k) cargo handling.

Values of these items can be determined only on the basis of assumptions of certain prices, which, like all market prices, are subject to wide fluctuation in any one place from time to time, and considerable differences in different parts of the world. A leading example of this condition is fuel price, concerning which the only thing that seems to be sure is a general upward trend everywhere, judging from past figures. Crew wages and food costs entering into subsistence are likewise unstable, but not so widely as fuel prices.

Consideration of such items must, therefore, involve a good deal of opinion and judgment, and appreciable differences in conclusions may well follow the use of maximum prices or wages in one calculation and minimum figures in another. However this may be, it is a fact that the quantities of these items to which the prices apply always favor the motorship. It necessarily follows, therefore, that *high prices of items of running expense make total operating costs more favorable to the motorship;* a very significant conclusion in view of present price tendencies.

Evaluation of fixed charges, or items of investment expenses, are even more dependent on opinion than prices of supplies or wages of labor, because these are largely fixed by the system of accounting used. Accountants differ widely in their practices as to interest charges on capital investment reduced to equivalent per ton-mile, and still wider differences are to be found in the treatment of depreciation, obsolescence and maintenance, both in finding the value of each, and in the relation of depreciation to maintenance on the one hand, and of obsolescence in relation to period of interest charges or to depreciation on the other.

As a consequence, all estimates of total expenses of operating one ship as compared with another must necessarily involve some more or less considerable variation when made up by different estimators, due to opinions on accounting; to estimates as to proper prices of supplies and wages; to voyages to be made; to days at sea or in port per year; to refueling points; and to relative amounts of cargo of the deadweight as compared with the measurement classes; and such items, all in addition to the determinable items of an engineering nature, such as fuel-consumption per hour per horsepower. These sources of variation will account for the many differences of opinion as to the relative value of one type of ship compared with another for a given service, which have always existed and always will.

In spite of all these variables, some of fact and others of opinion, entering into the estimate of the cost of operating a ship per year, or the cost of carrying freight per ton-mile, the fact remains that the only estimate worth while, must be based on the evaluation of individual items. It is also true that for all reasonable values of these items in comparing motorships with steamships as cargo carriers, the motorship will be found to be the most economical vessel operated on a trade route that is long enough.

To assist those interested in working out such cost comparisons, some convenient forms and tables have been developed, and for each item presents a brief discussion, with an estimate of a fair value for it for one size of ship. These should be useful to naval-architects, marine-engineers, ship-builders, ship-owners, and shipping interests generally, not only for the values of the items and estimates of totals here presented, but also as a means of guiding individual new estimates when it is desired to determine the effect of a change in any one item, due to a new condition, or price or service or to a difference in opinion as to the proper value.

The more common such cost-calculations become, and the more accurately they are made, the quicker will the shipping world come to a correct understanding of the commercial value of motorships and their proper place in water-borne freight transportation. Without such calculations, the question will remain one of opinion unworthy of supporting a real business conclusion as to the value of motorships as investments.

2. *Comparative Cargo-Capacities of Motorship and Steamship of* 100,000 *d.w.t.*

As cargo-carrying capacity is to be calculated by differences between total deadweight and that of supplies carried for deadweight cargo, each of thse items must be considered separately. A second calculation for measurement cargo (bales), measuring more than forty cubic-feet per ton can then be made.

In this comparison the first item is weight of machinery, and after it weight of fuel for a given voyage, with other supplies and stores. This comparison is made in detail for two ships—one a steamer and the other a motorship of identical hulls and shaft horsepower. The basis of the estimates is the steamer, taken as 10,000 d.w.c. and propelled by a single screw with geared-turbines and oil-fired Scotch boilers, and the usual steam auxiliaries for both engine-room and deck service This is quite generally accepted as the most economical cargo steamship.

The motorship is propelled by twin screws, with two four-cycle six-cylinder Worthington reversible marine Diesel-engines, direct coupled to the propeller-shaft and having Worthington auxiliaries. These auxiliaries include Diesel-electric generating-sets in the engine-room, generating electricity for ship lights and for operating electric motor-driven pumps and compressors in the engine-room, and steering-gear, winches and windlass on deck.

Each ship is powered with 2700 s.h.p. (shaft horsepower), giving the ships each a speed of 11 knots or 264 miles per day (nautical), assuming equal propeller efficiency for the twin-screws of the motorship and the single-screw of the steamship.

Basin tests of a single propeller placed in the normal position abaft the stern post and of twin screws placed out in free water have shown that the twin propellers can work with a very much higher speed and still attain the same efficiency as the slow running single-propeller. It should also be expected that the propulsive power in a seaway would be better maintained with two small deeply submerged propellers than with one large single propeller, which very likely will be lifted partly out of the water when the ship pitches.

Trials with sister ships—one with a single slow speed steam-engine, and another with higher speed twin screw Diesel-engine installations—have been carried out both in England and in Sweden, and have both shown that the twin screw arrangement is superior to the single screw, based on same shaft horsepower. In order not to complicate matters, the efficiency is here considered equal in both installations.

The *machinery weight* of the steam installation is estimated at 550 tons, and that of the Diesel installation at 630 tons, the difference, 80 tons, being in favor of the steamship. Taking the total deadweight capacity of the steamship to be 10,000 tons, then the question of machinery weights can be eliminated from further consideration by taking

the value 9920 tons for the motorship deadweight capacity.

The cargo-capacity deadweight will be 10,000 tons for the steamer, or 9920 for the motorship, less the sum of the weights of bunker-fuel, water and stores for each ship, and the numerical value of these items must be separately determined.

Stores for deck, engine and steward's department are estimated at about one ton per day for each ship, and while considerable variation in this figure is possible, even the largest reasonable value is so small a part of the total deadweight that it is hardly worth discussing.

Fresh water is required on both vessels for drinking and washing, the amount required being, at an outside figure, about twenty gallons per man per day with little or no reserve. Assuming a crew of about forty men all told, the nearest round number is three tons per day for each ship. In addition, the steamship will require some make-up water to equalize losses, and this is estimated at ten tons per day or about two per cent of the boiler evaporation, to be carried in tanks. The total water for the motorship depends on the number of days for which water must be carried, while for the steamship the number of days at sea determines the total make-up water. This factor of days at sea vs. days in port per voyage or per year, also enters into the total items and is worth some study.

Sea days in relation to *lay days*, depend on the length of the voyage, the speed of the vessel at sea and the estimated time of lading, unloading or waiting for cargo while lying in port. These same factors determine the total time of a round trip or turnaround, and the number of voyages per year. While almost any figure might be assigned to "lay days" as a matter of opinion, it is clear that whatever value be chosen, the ratio of "sea days" or "steam days" to the former will be greater the longer the voyage. The accompanying tables indicate this clearly, the first one being for the speed of the ship under consideration, the second for a faster vessel and different conditions.

From the figures of the schedule of Table I, the total weights of water to be carried in tanks for each of the three typical voyages are stated in Table III.

Fuel is the most important of the deadweight items, not only because it is the largest, but also because in it are found the largest differences between steamships and motorships. As it is assumed that the steamship will burn fuel-oil and that both ships will have double-bottom tanks, the comparison can be made directly. The weight required must be calculated from the fuel-consumption of the main engines and auxiliary machinery at sea and that of the auxiliaries in port, and the bunker or tank capacity for a given voyage or radius of action for given bunkers and tanks from the density of the fuel-oil of different grades obtainable.

TABLE III

Weight of Water in Tanks—Tons (long)

VOYAGE	ITEM	Steamship Out	Steamship In	Motorship Out	Motorship In
New York to Liverpool and return	Water per day....	13.	13.	3.	3.
	Days supply......	12.5	12.5	12.5	12.5
	Total required....	162.5	162.5	37.5	37.5
	Reserve..........	12.5	12.5	2.5	2.5
	Total in tanks....	175.	175.	40.	40.
New York to Buenos Aires and return	Water per day....	13.	13.	3.	3.
	Days supply......	22.5	22.5	22.5	22.5
	Total required....	292.5	292.5	67.5	67.5
	Reserve..........	32.5	32.5	7.5	7.5
	Total in tanks.....	325.	325.	75.	75.
New York to South Africa and return	Water per day....	13.	13.	3.	3.
	Days supply......	30.5	30.5	30.5	30.5
	Total required....	396.5	396.5	91.5	91.5
	Reserve..........	43.5	43.5	8.5	8.5
	Total in tanks....	440.	440.	100.	100.

TABLE I

Schedule for 11-Knot Vessel

VOYAGE	DAYS Lay	DAYS Steam	TURNAROUND Days	TURNAROUND Miles	Voyages per year (10 days overhaul)
New York to	10				
Liverpool to	21	12.5			
New York	11	12.5			
6439 miles	42	25.0	67	6439	5.3
New York to	10				
Buenos Aires to	21	22.5			
New York	11	22.5			
11,740 miles	42	45.0	87	11,740	4.1
New York to	11				
South Africa to	21	30.5			
New York	11	30.5			
16,000 miles	43	61.0	104	16,000	3.4

TABLE II

Schedule for 12-Knot Vessel

VOYAGE	DAYS Lay	DAYS Steam	TURNAROUND Days	TURNAROUND Miles	Voyages per year (25 days overhaul)
New York to	6				
Liverpool to	11	11.5			
New York	7	11.5			
	24	23	47	6439	7.23
New York to Cape Town	10				
Cape Town to	4½	32			
Algoa Bay to	4½	2			
E. London to	4½	1			
Port Natal to	4½	1			
Cape Town to	4	3			
New York	11	33			
	43	73	116	15,228	2.93
New York to	10				
Sydney to	7	37			
Melbourne to	13	2			
New York	10	38			
	40	77	117	20,217	2.9
New York to	10				
Panama to	1	9			
Yokohama to	3½	27			
Kobe to	4	1½			
Shanghai to	5½	3			
Hong Kong to	7	3			
San Francisco to	1	13			
Panama to	1	24½			
New York	11	9			
	44	90	134	23,291	2.54

While any oil may be classed as fuel-oil, it is common practice to regard oil at or near 16° Baume as low grade and suitable for boilers, and oil at or near 22° Baume as high grade and suitable for internal-combustion engines. The lighter oils with large Baume numbers bring higher prices because of the greater ease in handling them, due to greater fluidity and freedom from dirt.

Therefore, while Diesel engines can use any oil that can pass through the pumps, it is considered worth while to pay a little more for the lighter, cleaner, more fluid oils, to avoid the necessity for heating the heavier viscous oil to make it flow, and subsequently filtering and settling to clean it. On the other hand, with boilers, when a little heat more or less matters but little and dirt is less serious in oil, it is customary to buy a cheaper oil. However, even there are exceptions, some engineers and owners having come to the conclusion that a little better grade of oil is worth the comparatively small increase in price.

In this comparison, it is assumed that 16° Be oil will be used for the boilers, and 22°. Be oil for the internal combustion engines. These oils, according to Table IV, weigh 7.994 lbs. and 7.677 lbs. per U. S. gallon, or 335.74 and 322.43 lbs. per 42-gallon barrel respectively. The former requires 6.67 bbls. per long ton of 2240 lbs., and the latter 6.95 bbls.

Supplies of oil are now becoming available at an increasing number of points reached by ships throughout the world, as shown in Appendix Table XVIII., which gives a partial list of such fuel-oil stations maintained by various oil companies.

As the double-bottom bunkers of the motorship can hold sufficient oil for about 20,000 miles, it is evident that this type of vessel is more independent of the location of these fuel-oil stations than is the steamer.

Fuel-consumption in lbs. per hour per s.h.p. (shaft horsepower) can be pretty accurately predicted for main engines from data on hand, and the same is true for engine-room auxiliaries, or the total for all purposes at sea. There is, however, considerable latitude in estimates of port requirements for cargo handling and general ship purposes. But this is not serious as the amount is small in comparison with consumption at sea. experts trying to make a record, can be accepted on short runs with very long port stays, a quite special case. No extraordinarily low figures obtained on trial trips, or with machinery in abnormally fine condition in the hands of builders' experts trying to make a record, can be accepted in estimates of commercial ship operation. For this purpose the fuel-consumption figures must be thos eobtainable in every day service with engine-room crews of average quality and skill.

The fuel-consumption of a Diesel-engine is a very definite figure, and so long as the exhaust is clear there is absolutely no difference in the consumption during ordinary tests in the shop, or at any time in service in the ship. The consumption in large four-cycle Diesel engines is about 0.41 lb. of fuel-oil per s.h.p. To this figure has to be added the fuel-consumption of the auxiliary engine generating electricity for motor driving the pumps, the separate compressors, the steering-gear and for the electric lights. The power required for this service at sea is about b.h.p.; the consumption in these smaller engines is about 0.44 lb. per b.h.p., whereby the total consumption of a 2700 s.h.p. plant will be

$$\frac{(2700\times0.41)+(50\times0.44)}{2700}=0.42 \text{ lbs.}$$

Adding about 7 per cent for incidental losses or waste, there is obtained 0.45 lb. per shaft h.p. for all purposes at sea. The

TABLE IV
Fuel-Oil Weights

Baume	Lbs. per Gal.	Lbs. per Bbl. (42 Gal.)	Barrels (42 Gal.) per ton Short (2000 lb.)	Long (2240 lb.)
14	8.102	340.28	5.877	6.583
15	8.052	338.18	5.914	6.624
16	7.994	335.74	5.957	6.672
17	7.935	333.27	6.001	6.721
18	7.885	331.17	6.039	6.764
19	7.835	329.07	6.078	6.808
20	7.777	326.63	6.123	6.858
21	7.727	324.53	6.163	6.902
22	7.677	322.43	6.203	6.947
23	7.627	320.33	6.243	6.993
24	7.577	318.23	6.285	7.039
25	7.527	316.13	6.326	7.086
26	7.477	314.03	6.369	7.133
27	7.435	312.27	6.405	7.173
28	7.385	310.17	6.448	7.222
29	7.344	308.45	6.484	7.262
30	7.294	306.35	6.528	7.312

total per day for all purposes at sea for the motorship is, therefore $2700 \times .45 = 1215$ lbs. per hour, $= 29160$ lbs. per day of 24 hours, $= \frac{29160}{322.4} = 90$ bbls. of 22° Be oil, $= \frac{29160}{2240} = 13$ tons (long).

In port, the motorship may use, one or all of its one, two or three auxiliary Diesel-engine generating sets, supplying current for all purposes, including electric winches for cargo handling. A total of 2000 b.h.p. *hours per day* of auxiliary engines will carry all reasonable winch loads on a 10,000 tons ship, with the ship's lighting and pump service. This is equivalent to an average of 150 b.h.p. for 10 hours for hoisting or lowering and 21 b.h.p. for 24 hours for ship service. This total power requires $2000 \times 0.44 = 880$ lbs. fuel per day—0.4 ton (long) $= \frac{880}{322.4} = 2.7$ bbls. in round numbers.

Steam machinery fuel-consumption estimates are subject to much wider variation, as they may easily differ one from another by 100 per cent, due to differences in design or in condition in which the boiler and machinery is maintained. As the geared-turbine is considered a highly economical equipment with high-pressure superheated steam and good vacuum, it is taken as a basis of comparison. While test water rates of 12 lbs. are obtained for these turbines, with boiler evaporation of 14 lbs. steam per lb. of oil or better and 12 per cent of turbine steam or less for auxiliaries, actual ship service with present day crews is not so good.

Losses in boiler efficiency, losses in vacuum, steam for heating the viscous fuel oil and other similar items will require more fuel. A fair service water rate would be 13.6 lbs. of steam per hr. per s.h.p. for the turbine and 14 per cent of this or 1.9 lbs. per s.h.p. for auxiliaries, making a total of 15.5 lbs. per hr. per s.h.p. This is equal to $15.5 \times 2700 = 41{,}850$ lbs. of steam per hr., or about 450 tons (long) per day. A fair service value for evaporation is 13 lbs. steam per lb. of oil, so the oil consumption per hour is $\frac{41850}{13} = 3220$ lbs. per hour $= \frac{3220}{2700} = 1.2$ lbs. per hour per s. h. p. This is equivalent to $24 \times 3220 = 772{,}800$ lbs. per day $= 34.5$ tons (long) per day $= 34.5 \times 6.67 = 230$ bbls. for 16° Be oil. This is 2.65 times the motorship requirement by weight and 2.55 times by volume.

Steamship fuel-oil consumption in port is proportionately large, because steam winches have very high water rates, as is well known, and there is considerable condensation in the long steam pipes. A conservative estimate is 5 lbs. of fuel-oil per b.h.p. hr., and for the 2000 b.h.p. hours of port service per day, the oil required will be 10,000 lbs. or 4.5 tons (long) $= 4.5 \times 6.67 = 30.0$ bbls.

The fuel item of the deadweight can now be calculated for the three typical voyages, and it will be assumed that oil is to be carried for a round trip and with some reserve. These figures are given in Table V and the reserve is estimated at about one-eighth of that required for consumption outbound.

The cargo-capacity deadweight is determined by subtracting from 10,000 tons the sum of each of the items of deadweight separately computed, fuel water and stores, and these figures are collected in Table VI. It is apparent from the table that in spite of a handicap of 80 tons excess machinery weight, with this particular Diesel machinery, the motorship has in all cases a greater cargo-carrying capacity than the steamship, because of its low fuel-consumption. It is also clear that this difference is greater for the longer voyages by increasing margins, which again indicates the special superiority of motorship for this long-voyage class of service.

Bulk cargo (measuring over 40 cu. ft. per ton), conditions are also favorable to the motorship as the following figures will show. The engine-room of the motorship carrying all the machinery except deck-gear is shorter than the combined engine and boiler rooms of the steamship.

(*To be Continued in an October Issue*)

HOW AMERICA'S VALUABLE OIL IS WASTED

A contemporary recently published a list of 2,635 boilers supplied by 13 firms for installation on Emergency Fleet Corporation ships. Most of these boilers are oil-fired, and burn three times as much oil as Diesel engines of the same power out-put.

TABLE VI
Deadweight Distribution and Cargo Capacity

VOYAGE	ITEM	STEAMSHIP Out	STEAMSHIP In	MOTORSHIP Out	MOTORSHIP In
New York to Liverpool and return 6,439 miles, 42 lay days, 25 sea days, 67 total days	Fuel in bunkers......	1,180	650	380	210
	Water...............	175	175	40	40
	Stores..............	70	70	70	70
	Excess Machinery Wt.	....	....	80	80
	Total...............	1,425	895	570	400
	Total Deadweight Cap.	10,000	10,000	10,000	10,000
	D. W. Cargo by Differ.	8,575	9,105	9,430	9,600
New York to Buenos Aires and return 11,740 miles, 42 lay days, 45 sea days, 87 total days	Fuel in bunkers......	1,960	1,090	680	380
	Water..............	325	325	75	75
	Stores..............	90	90	90	90
	Excess Machinery Wt.	....	....	80	80
	Total...............	2,375	1,505	925	625
	Total Deadweight Cap.	10,000	10,000	10,000	10,000
	D. W. Cargo by Differ.	7,625	8,495	9,075	9,375
New York to South Africa and return 16,000 miles, 43 lay days, 61 sea days 104 total days	Fuel in bunkers.......	2,590	1,440	910	500
	Water..............	440	440	100	100
	Stores..............	100	100	100	100
	Excessive Machinery Wt.	....	....	80	80
	Total...............	3,130	1,980	1,190	780
	Total D. W. Capacity.	10,000	10,000	10,000	10,000
	D. W. Cargo by Differ	6,870	8,020	8,810	9,220

SUMMARY

	STEAMSHIP Voyage	STEAMSHIP Year	MOTORSHIP Voyage	MOTORSHIP Year
Liverpool, 5.3 voyages per year Cargo Tons......................	17,680	93,704	19,030	100,859
Buenos Aires, 4.1 voyages per year Cargo Tons	16,120	66,092	18,450	75,645
South Africa, 3.4 voyages per year Cargo Tons..................	14,890	50,666	18,030	61,302

TABLE V
Weight of Fuel in Bunker Tanks—Tons (long)

VOYAGE	ITEM	STEAMSHIP Out	STEAMSHIP In	MOTORSHIP Out	MOTORSHIP In
New York to Liverpool and return, 6,439 misle	Fuel per day in port..	4.5	4.5	.4	.4
	Port fuel, 42 days....	189.0	94.5	16.8	8.4
	Fuel per day at sea...	34.5	34.5	13.0	13.0
	Sea fuel 25 days......	826.5	431.3	325.0	162.5
	Total required........	1051.	526.	342.	171.
	Reserve.............	129.0	129.0	38.0	38.0
	Total carried........	1180.	650.	380.	210.
New York to Buenos Aires and return 11,740 miles	Fuel per day in port..	4.5	4.5	.4	.4
	Port fuel 42 days....	189.0	94.5	16.8	8.4
	Fuel per day at sea...	34.5	34.5	13.0	13.0
	Sea fuel 45 days......	1552.	776.	585.	293.
	Total required.......	1741.	871.	602.	301.
	Reserve.............	219.	219.	78.	78.
	Total carried.........	1960.	1090.	680.	380.
New York to South Africa and return 16,000 miles	Fuel per day in port..	4.5	4.5	.4	.4
	Port fuel 43 days.....	193.	97.	17.2	8.6
	Fuel per day at sea...	34.5	34.5	13.0	13.0
	Sea fuel 61 days......	2105.	1052.	793.	386.
	Total required.......	2298.	1149.	810.	395.
	Reserve.............	287.	287.	100.	100.
	Total required.......	2590.	1440.	910.	500.

PARSONS TURBINE TO PARSONS DIESEL

According to a British contemporary, Sir Charles Parsons, of turbine fame, is developing a new type of Diesel engine. Evidently he realizes that the day of the turbine drive for merchant-ships has passed its peak, except in very high powers.

EXPERIMENTAL DIESEL-ENGINE ABANDONED

Work on the Delong Diesel-engine has been abandoned by Hoovens, Owen & Rentschler of Hamilton, Ohio. It may be remembered that the construction of this engine was originally commenced by Pusey & Jones for Hannevig interests, but some time ago was taken-up at Hamilton, Ohio, by the Hoovens, Owen & Rentschler Company, who proposed to construct a 6-cylinder 4-cycle engine of 2000 i.h.p. at 100 r.p.m. of this design. The entire engine was to be constructed of riveted structural-steel, including the bed-plate, and the single-cylinder experimental model is about 70 per cent completed. We understand that the designer is looking for another company to complete the development work. However, it does not mean that Hoovens, Owen & Rentschler have given-up the idea of building marine Diesel engines. We expect shortly to announce that they will build an European engine.

British Admiralty Experiments with Diesel Engines

Interest to Engine Builders

By Engineer-Commander C. J. HAWKES, R. N. (ret.)*

IN 1916, as the result of the representations of the Board of Invention and Research, it was decided to establish an Admiralty Engineering laboratory on a small scale, the work, at first, to be confined to experiments with internal-combustion engines. Arrangements were at once made to get a small designing and testing staff together, erect the necessary workshop machines and design and obtain experimental plant and engines. Sir Dugald Clerk was appointed Director of Engineering Research.

The question of the material and design of pistons of submarine oil-engines was referred to the Board by the Engineer-in-Chief of the Navy. It was decided to construct a single-cylinder oil-engine for experimental purposes, utilizing, so far as possible, the parts of a standard submarine-engine. The drawings of the piston, connecting rod, bedplate, and other parts not of the standard design were made at the Board of Invention and the engine was constructed and erected at the works of Messrs. Ruston & Hornsby, Lincoln. The engine was first run without load on 17th July, 1916.

Several designs of pistons were considered, including pistons of aluminium-alloy in two pieces, and pistons having aluminium-alloy-heads and suitably lightened bronze or cast-iron skirts. Eventually it was decided to commence the experiments with a piston of aluminium-alloy and, in order to keep down the weight of the piston a comparatively low copper content was decided upon. It is interesting to note that the original piston is still in use and it has been run for a considerable time at comparatively high speeds and high mean-pressures.

The trunk-piston was divided at the gudgeon-pin centre and the two top-end bearings were carried between its upper and lower portions—the gudgeon-pin, to facilitate dismantling, being at first made a driving fit into the eye of the connecting-rod. This design had the object of obtaining a slightly greater gudgeon-pin bearing-surface. The top-end brasses, which were lined with white metal, were not adjustable. Lubrication was effected by forced-feed from the crank-shaft through the centre of the connecting-rod and thence through channels in the hollow gudgeon-pin to the bearings. The bearings were held in position by steel end-plates. Six cast-iron piston-rings were fitted in addition to a scraper ring, but, with the object of reducing the possible wear of the piston-grooves, the width of the working-faces of the rings were made ¼ in.—as compared with ⅜ in. in the standard cast-iron pistons. Aluminium guards were fitted on the lines of the standard submarine-engines in order to prevent lubricating oil, either from the top-end bearings or splash from the crank, finding its way on to the walls of the cylinder-liner. Splash-guards were also fitted over the crank-webs. The connecting-rod was made of 30 to 35 tons steel and was of I section—the connecting-rods of standard submarine engines being of round section.

The diameter of the cylinder of this engine (which, for convenience, is hereafter referred to as the "Unit" engine) is 14½ in., stroke 15 in., and of 100 nominal B.H.P. at 380 revs. per min. Other parts followed Messrs Vickers' standard design. Solid-injection was first used in this engine, but later, air-injection was fitted for experiments with a modified type of air injection-valve.

After the engine had been running at the full nominal load for some considerable time it was opened up for examination. It was found that the gudgeon-pin was slightly slack in the connecting-rod and it was decided, therefore, to modify the skirt portion of the piston so that it would pass over the foot of the rod for dismantling and thus permit a "shrunk-in" gudgeon-pin to be fitted.

When these modifications had been carried out the engine was transferred from the Ruston-Hornsby plant to the Admiralty Engineering Laboratory and the trials were continued in September, 1917. The engine was run at or above 100 B.H.P. at revolutions from 380 to 500 per minute and at mean-pressure from 100 to 140 lbs. per square-inch, and it was not opened out for examination again until July, 1918. It was then found that the piston was in good condition but the white-metal of the gudgeon-brasses had worn slightly. It appeared evident that this wear was largely due to the fact that the oil grooves had not been cut exactly in accordance with the instructions on the drawing, and this resulted in reducing the supply of lubricant to the grooves. It was also found that the brasses had hammered very slightly into the aluminium body of the piston and there was evidence that the side clearances between the connecting-rod and the brasses were insufficient.

It was decided to bore the eyes of the piston larger, make new brasses of correspondingly greater thickness, with flanges at each end, and to fit more substantial keys to prevent the brasses turning in the piston—as the small keys originally fitted were found to be slack. The experiments have been continued since August, 1918, at mean indicated pressures up to 140 lbs. per square inch, but it has not been necessary to make any further modifications to the piston. Whenever the piston has been dismantled it has been found in good condition and careful gauging has shown that there is no appreciable wear either in the body of the piston or in the grooves—and, so far, there is no indication of "growth." The cast-iron cylinder liner is in excellent condition.

The weights of the aluminium-alloy piston and I section connecting-rod of the unit engine are appreciably less than the weights of the corresponding parts of the standard submarine engine, with the result that the inertia forces in the former at 500 R.P.M. are approximately the same as in the latter when running at 380 R.P.M. The comparative weights of the reciprocating and rotating parts of the experimenal cylinder and the standard engines are shown in Table. I.

high speeds, etc., no further seizures have taken place. From the experience gained it may be taken that the clearances required with an aluminium-alloy piston should be about 50 per cent. greater than the clearances necessary with a cast-iron piston. Should a cast-iron piston seize it generally results in damaging the liner as well as the piston, but in the case of the aluminium alloy piston it was found that a seizure did not damage the surface of the liner in any way. Further, it was found that as soon as the engine had cooled down slightly after a seizure the aluminium-piston was quite free.

There is no doubt, so far as present experience is concerned, that aluminium-alloy pistons, although slightly greater in first cost, have many advantages over cast-iron pistons. Further experience will shortly be available as to their behavior under actual service conditions and it will then be possible to decide whether their extended use for submarines is justified. In the meantime other Admiralty experimental engines, including the two-stroke cycle type, have been or are to be fitted with pistons of aluminium-alloy for further test.

In view of the results obtained with the "Unit" engine it was decided to test the capacity of the piston to withstand higher mean-pressures by supercharging and also to run at higher speeds. The two methods of supercharging considered were (1) to compress to the supercharging pressures the whole of the air required by the engine by means of a blower or pump, the air passing through the induction valve, or (2) to allow the engine to draw air from the atmosphere through the induction-valve in the ordinary way and to add at or about the commencement of compression the additional air for supercharging through ports uncovered by the piston or through an additional valve in or near the cylinder-head. The alternatives were fully considered, but as the principal object at that time was to test the aluminium-alloy piston it was decided to adopt (1) as it did not involve any structural alterations to the engine.

TABLE I

Comparison of Weights of Pistons and Connecting Rods in Experimental and Standard Submarine Engines.

	Experimental Engine.	Standard Submarine Engine.
Cylinder diameter	14½ in.	14½ in.
Length of stroke	15 in.	15 in.
Revolutions per minute	380	380
Weight of piston, with rings, bushes (in the case of experimental engine), guards, etc.	213 lbs	390 lbs.
Weight of connecting rod, with gudgeon pin and large end bearing and bushes (in the case of standard engine)	290 lbs.	423 lbs.
Reciprocating weights (includes two-thirds weight of connecting-rod without palm end)	310 lbs.	560 lbs.
Rotating weights (includes palm end and one-third weight of connecting-rod)	193 lbs.	253 lbs.

With the particulars given in the above Table the mean-pressure on the various bearings throughout the cycle, 380 R.P.M., were obtained for each engine and the results are shown in Table II.

TABLE II

Mean Total Bearing Pressures throughout Cycle in Lbs.

Engine.	Gudgeon Pin.	Crank Pin.	Cylinder Liner.	Main Bearings.
Experimental engine	12,320	16,200	1,420	16,200
Standard engine	15,250	20,260	1,840	20,260

It will be seen, as would be expected, that there is a considerable reduction in the mean total loadings of the bearings due to the use of the aluminium-alloy piston and lighter connecting-rod and, as the mean rubbing velocities of the various bearings are the same for both engines at 380 R.P.M., this reduction is a measure of the increase in the mechanical efficiency of the experimental engine as compared with the mechanical efficiency of the standard engine. This increase in mechanical efficiency would appear to be of the order of 2 per cent.

The coefficient of linear expansion and the thermal conductivity are greater for aluminium than for cast-iron and, in the absence of information so far as large engines were concerned, it was difficult in the design stage to decide on the clearances which should be provided between the aluminium-alloy piston and the liner. It was essential, that the clearances should not be greater than were actually necessary and eventually it was decided to make the clearances similar to those usual with cast iron in Diesel engines and to note the results. When the engine was first started, and after the engine had been running at a small load for some time, the piston seized. The piston was removed and examined and it was found that it had been in contact with the liner over nearly the whole of its surface and the metal was scored slightly. The piston was therefore "draw-filed" and replaced and the engine again put on load. At the higher loads there was a slight seizure and again the body of the piston was filed where it had been bearing hard on the liner. Since that time, although the engine has been running at

It was consequently arranged to compress to the supercharging pressure the whole of the air required by the engine by means of a standard Roots blower, driven by belt from an electric motor. The blower delivered air under pressure to a reservoir, which was fitted with a combined relief and pressure regulating valve, so that the supercharging air could be adjusted to any predetermined pressure within the capacity of the blower. A three-way cock was fitted in the induction pipe so that the engine could take its supply of air either from the atmosphere or from the reservoir. This arrangement gave no trouble but it was found that the temperature of the air delivered at 3 or 4 lbs. pressure after a time rose appreciably and a water jacket was therefore fitted to the blower.

Tests were then carried out with and without supercharging at various speeds up to 500 R.P.M. using the maximum quantity of fuel-oil delivered by the fuel-pump. A six-hole sprayer was necessary at the higher speeds and the pressure in the solid-injection system was maintained, as nearly as possible, at 4,000 lbs. per square-inch by adjusting the fuel-valve roller clearance—thus vary-

*Read at the Summer Meetings of the Sixty-first Session of the Institution of Naval Architects, July 8, 1920.

ing both the lift and period of opening of the fuel-valve. Further, the compression-pressure was 380 lbs. per square-inch and the average initial, or maximum, pressure was kept at about 630 lbs. per square inch by adjusting the timing gear as necessary for each test. The same brand of fuel oil was used throughout, viz., heavy shale oil of specific gravity 0.86 at 60° F. The quantity and rise in temperature of the cooling water to the jacket, cylinder-cover and exhaust-valve were measured.

During the tests the blower was run at its lowest speed but the amount of air delivered was in excess of that required at all engine speeds. A calculation had to be made, therefore, based on the curves of output and power furnished by the makers of the blower, in order to obtain the power required to supply the air actually used in the engine. The blower was not very efficient and the calculated power required to supply the super-charging air were known to be in excess of those which would be necessary in practice. The results obtained during the 500 R.P.M. series of tests which were run with supercharging pressures corresponding to 0, 2, 4, 6 and 8 in. of mercury (as measured by a mercury gauge in communication with the reservoir) are shown graphically in Fig. 1. The fuel-consumptions per B.H.P.-hour inclusive of the blower are estimated. Each trial was 1½ hours' duration.

Although the powers developed during the tests were limited by the capacity of the fuel-pump, the results obtained could not be regarded as satisfactory. The exhaust was not clear during any test and it was evident that it was necessary either to make some alteration to the fuel sprayer or to adopt a different system of fuel-injection. It was therefore decided that no good purpose would be served by continuing these tests and it was consequently arranged to experiment with the fuel-injection system and to defer the super-charging tests until a later date.

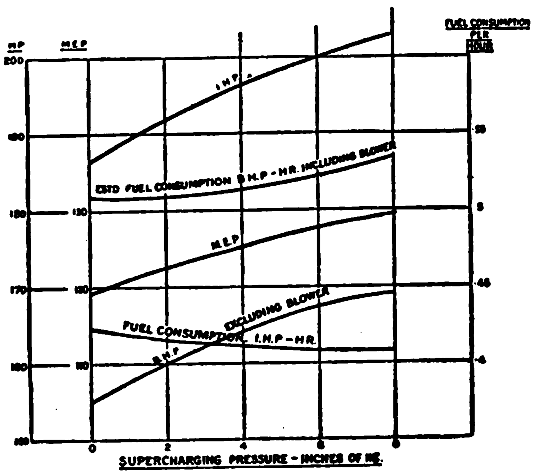


FIG. 1.

Better results, both as regards power and fuel-consumption, would have been obtained by running these tests at higher initial pressures, but it was desirable at least for the present, to limit the maximum pressure to that usually worked to on Service. The results could also have been improved by using a higher fuel-pressure in the solid-injection system but, again, it was considered advisable at that stage, and with the fittings then in use, to limit the pressure to 4,000 lbs. per square inch. During the later tests diagrams were taken from the fuel system with the object of ascertaining the variation of pressure during the cycle. For this purpose an ordinary hydraulic indicator was used, but as the fuel-oil was found to leak past the piston a U-pipe connection was made to the indicator and filled with heavy oil—so that the heavy-oil was in contact with the piston. This overcame the difficulty and it is considered that reliable records of the variation in pressure were obtained. It was found that with a gauge pressure of 4,000 lbs. per square inch in the fuel system, with the engine running at 420 R.P.M., the maximum pressure was 4,560 lbs. and the minimum pressure 3,400 lbs. per square inch.

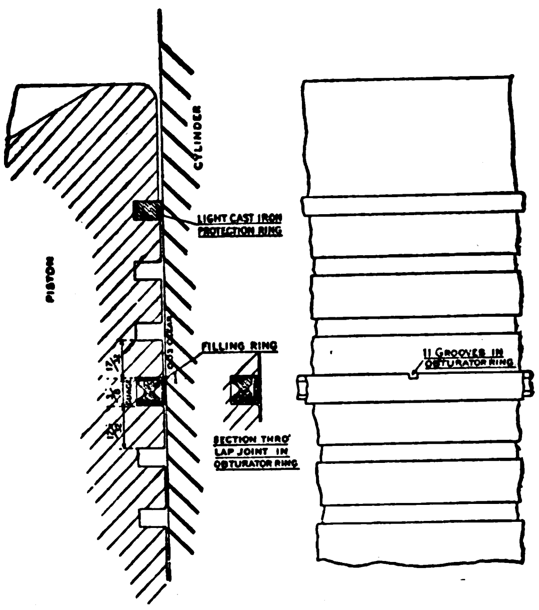
The exhaust-pipe outlet to the atmosphere is some considerable distance from the engine and for convenience it has been arranged to spray water into the first of the two silencers fitted and to note the color of the discharge from the silencer drain by passing it over a plate of glass painted white on its under side. It has been found that this method is very sensitive and can always be relied upon to give a true indication of the color of the exhaust.

The indicator rig originally fitted to this engine was considered to be unsatisfactory and a new gear was fitted, an arrangement of which is shown in Fig. 2 (Plate I.). It will be seen that a steel tape, 0.006 in. in thickness, has one end connected to the piston and the other end connected to the rim of an aluminium wheel, which is mounted on a small shaft carried in a bracket attached to the engine framing. This tape passes over a ball-bearing pulley 1½ in. diameter. The shaft carrying the aluminium wheel also carries the pulleys to which the tension springs are connected and the pulley from which the indicator tape is taken. By this means a true copy of the movement of the piston can be obtained. Some difficulties were experienced in connection with the tension springs and the tape fastenings but by running the whole of the gear in the open by an electric motor, so that all parts were under observation, these difficulties were readily overcome. Various minor alterations were made later but the principle of the gear has remained the same. A large number of strands of rubber have been successfully used in place of the tension springs.

It may be interesting to mention that an obturator-ring has been fitted to the piston since August, 1918, and has given fairly satisfactory results. When it was decided to fit an obturator-ring to the "Unit" engine for experiment, provision was made for a cast-iron protection ring designed to give a radial pressure of about 1 lb. per square inch. Further, the clearance between the edge of the obturator ring and its groove was reduced to 0.002 in.—as by this means it was considered that the pressure behind the ring would, by wire-drawing, be reduced to a minimum.

The arrangement of the L sectioned obturator ring in the "Unit" piston is shown in Fig. 4. The material used is phosphor-bronze and the thickness of the ring is 0.05 in. A lap-joint, riveted and silver soldered to one end of the ring, is provided to ensure gas tightness past the gap. A filling-ring is fitted, made in halves spigoted together—its width being such that it just allows freedom of movement of the obturator ring.

When the obturator-ring was fitted to the "Unit" engine the compression ratio was increased, as it was uncertain whether the ring would be gas-tight when starting up. Later, however, the compression was reduced again to 380 lbs. per square inch at 380 R.P.M. When the engine was first run with the obturator-ring, especially for about 15 minutes after starting, an appreciable quantity of gas passed the piston into the crank case—so the ring was removed and eased slightly to give it more freedom. It was clear that only portions of the ring were in contact with the liner and its surface was therefore smoothed-up as necessary and 11 slots, 1/32nd of an inch deep and 1/16th of an inch wide, were fitted, as shown in Fig. 4. At the same time the clearance between the edge of the ring and the piston groove was increased from 0.002 in. to 0.003 in. These slight modifications resulted in a distinct improvement and the ring worked satisfactorily with mean indicated-pressures up to 140 lbs. per square-inch.



UNIT ENGINE. ARRANGEMENT OF OBTURATOR RINGS IN PISTON.

FIG. 4.

No leakage was apparent although the maximum compression pressure was very slightly less than that previously obtained with the full number of cast-iron rings with the same compression ratio in use.

There was a very decided knock in the piston at the end of the compression stroke and after running for a total of about 30 hours it was decided to examine the piston and obturator ring. The obturator-ring was found to be quite free and bearing generally and there was no measurable wear. The ring was therefore replaced and, in view of the previous knocking of the piston, two additional light cast-iron rings were fitted below the obturator ring. These additional rings, which were intended to act as "buffer' rings, practically cured the knocking but they must add slightly to the piston friction of the engine. It is probable that this knocking could have been avoided by reducing the piston clearance but nothing could, course, be done with the existing piston; neither was it desirable in view of running the engine at comparatively high mean-pressures. After running for about 150 hours at various powers the obturator-ring was again measured and the wear appeared to be about 0.001 in., while the maximum wear in the groove of the piston when gauged was found to be 0.008 in.

So far the obturator-ring is promising but it has been tested under very favorable conditions and further experience is necessary before any recommendations could be made in regard to its general use in Naval Service engines. There has been no opportunity to ascertain the actual reduction in piston friction resulting from its use. There is no doubt, however, that the engine is more free than formerly and its mechanical efficiency has been slightly increased. It is not known whether any experiments have been made to ascertain whether obturator rings would work satisfactorily when running over ports, such as those fitted in two-stroke cycle engines.

Very good results have been obtained with the "Unit" engine both with the solid and with the air injection systems. Instructions were received to carry out experiments with the object of reducing the tendency of the standard engines to smoke when using solid injection. A large number of tests were made and eventually smokeless combustion was obtained with the "Unit" engine at all powers from 100 B.H.P. to 25 B. H. P., and the consumption of fuel-oil at 100 B.H.P. and 380 R. P. M. was just under 0.4 lb. per B.H.P.-hour.

Having in view the fact that the tests were carried out with a single-cylinder engine, fitted with a cam-shaft driving mechanism designed for a multi-cylinder engine, this figure for consumption is remarkably good. The fuel used was shale-oil having a specific gravity of 0.86 at 60° F. During all these tests the fuel-oil was very carefully measured and it may be mentioned that during a six hours' continuous test the variation in the consumption, recorded half hourly, was under 1 per cent. The "Unit" engine is coupled to a standard Heenan & Froude dynamometer for absorbing the power.

Tests were made with the above engine when using air-injection and the fuel-consumption at 100 B.H.P., after making the necessary allowance for the power required to drive the air compressor, was practically the same as the fuel-consumption when using solid-injection.

300 B.H.P. SINGLE-CYLINDER ENGINES

Early in 1918, several British firms were asked to produce designs of single-cylinder experimental engines of from 300 to 400 B.H.P. and one of these engines is now approaching completion. At about the same time a preliminary design for an experimental four-stroke single-cylinder engine of about 300 B.H.P. was prepared by the Admiralty Engineering Laboratory and instructions were received to proceed with the working drawings on 1st May, 1918. The latter engine was constructed at Chatham Dockyard. Owing to space requirements it was eventually decided to design a square engine, 20 in. diameter by 20 in. stroke, developing its full power at 390 R.P.M. The piston-speed aimed at was, therefore, 1,300 ft. per minute—which was an advance on previous practice. Although all the drawings were completed before any information was available as to the German designs it is interesting to note that the principal dimensions of the Laboratory engine correspond closely with the dimensions of the German engines—the cylinder diameter of the latter being 20.8 in., stroke 20.8 in., and developing approximately 300 B.H.P. at 380 R.P.M.

(*To be Continued in the October issue of "Motorship"*)

THE NORWEGIAN MERCANTILE MARINE

On June 1st, 1920, the Norwegian merchant marine, consisted of the following ships:

Motor-Vessels	1416	179,105 gross tons
Steamships	1849	1,720,949 gross tons
Sailing Craft	446	243,805 gross tons
Total	3711	2,143,859 gross tons

Many of the sailing-vessels are fitted with oil-engines as auxiliary power. We presume that motor fishing-vessels are included in the "motor-vessel" figures. That there are 1416 motorcraft denotes the importance of the oil-engine industry in Norway.

Motor-Auxiliary Versus Sailing-Ship

When lecturing before the Society of Automotive Engineers and the Society of Mechanical Engineers in April of last year, the Editor of "Motorship" put up a strong plea for the motor-auxiliary sailing-vessel, particularly steel craft of this type, and made clear the reasons why many war-time wooden auxiliary schooners were failures or only partially successful. He inferred that the mistreatment of this promising type of cargo-carrier had been most unfortunate, because when such ships had been properly designed, built and adequately installed with a good oil-engine, and sensibly operated, it had been conclusively demonstrated that the motor-auxiliary could more than hold its own against the oil-fired, or coal-burning, full-powered steel *steam*ship, especially on routes favored with trade-winds.

Endorsement of the Editor's claims is supported in the figures in this article concerning the operating costs and voyages of two steel schooners, one without power and the other with two 300 shaft h.p. Winton Diesel-engines for auxiliary propulsion. The Editor, it may be remembered, advised certain powers for various tonnages and gave 500 shaft h.p. and 7½ knots speed as being very suitable for a sailing-ship of 2000 tons d.w.c., and pointed out that the fuel-consumption would be 14 to 16 barrels of oil per day under power.

The "Chas. Gawthrop" at a Spanish port

As it happens, the auxiliary schooner, "Chas. S. Gawthrop," of which I have voyage records before me is of 1960 tons d.w.c., 600 shaft h.p. and 7½ knots speed on an average fuel-consumption of 14 barrels per day. This perhaps may add to the interest of the following comparisons. The name of the sister non-powered sailing-schooner is the "W. H. Woodin." Both vessels are owned by the Woodin Transportation Company of Wilmington, Del.

These two schooners are of exactly the same dimensions and differ only in that one is strictly a sailing-schooner and the other is equipped with Winton Diesel-motors of 600 shaft horsepower. The latter ship was described in "Motorship" of January, 1920, on page 46.

GENERAL DESCRIPTION

	SAILING SCHOONER	MOTOR SCHOONER
Length (overall)	230'0"	230'0"
Length (B. P.)	210'0"	210'0"
Beam (moulded)	39'0"	39'0"
Moulded Depth	24'10"	24'10"
Draft	23'5"	2'35"
Cargo Capacity	2,220 tons	1,960 tons
Fuel Capacity	nil.	30,000 gals.
Approximate first-cost per ton cargo carried	about $100.00	$165.00
Total Cost	$230,000.00	$330,000.00
Trial Speed		9.12 knots
Average speed under power loaded	nil.	7-¾ knots
Radius under power	nil.	7,000 nautical miles

This comparison is based on transatlantic service from Norfolk to the West French Coast. The sailing schooner under favorable conditions could make four round trips per year, and the motor schooner under similar conditions can make seven trips per year. The figures are made on a basis of carrying coal east and returning in ballast.

EARNING CAPACITY PER YEAR

	SAILING SCHOONER	MOTOR SCHOONER
No. of trips	3	7
Cargo Carried	6,660 tons	13,720 tons
Receipts		
@ $19.00 per ton	$126,540.00	
@ $20.00 per ton		$274,400.00

COST OF OPERATION

Crews' Wages

Operating Cost Comparisons Between Two Steel Schooners of Exactly Similar Dimensions Now in Service

By REX W. WADMAN

	SAILING SCHOONER	MOTOR SCHOONER
Captain	$310.00	$325.00
1st Mate	200.00	200.00
2nd Mate	175.00	175.00
Chief Engineer	....	300.00
1st Ass't Engineer	....	250.00
2nd Ass't Engineer	....	175.00
Deck Engineer	125.00	125.00
3 oilers at $125.00	....	375.00
8 Sailors at $100	800.00	800.00
Steward	175.00	175.00
Cook	150.00	150.00
Messboy	80.00	80.00
Carpenter	130.00	130.00
Total per month	$2,145.00	$3,260.00
Total per year	25,740.00	39,120.00

Food
16 men at $2.25 per day
12 months equals $13,140.00
22 men at $2.25 per day
12 months equals $18,067.50

COST OF INSURANCE PER YEAR AT PRESENT RATES

Sailing Schooner rate 10½%	$23,310.00
Motor Schooner rate 15%	48,510.00

The above figures have been compiled assuming similar operating conditions for the two vessels. As a matter of fact in actual operation the sailing schooner in the past 18 months has made but one trip coal laden to Santos and is now loading for her second trip from Baltimore with coal for a French port. The motor-schooner on the other hand in the past six months has made the following trips. One trip* light from the Delaware River to the Gulf and a return trip loaded with sulphur, one trip to Havana with coal.

* See tabulation of different trips of the "Gawthrop"

MOTORSHIP CHARLES S. GAWTHROP

Wilmington to Sabine, Nov. 13, 1919—Dec. 10, 1919

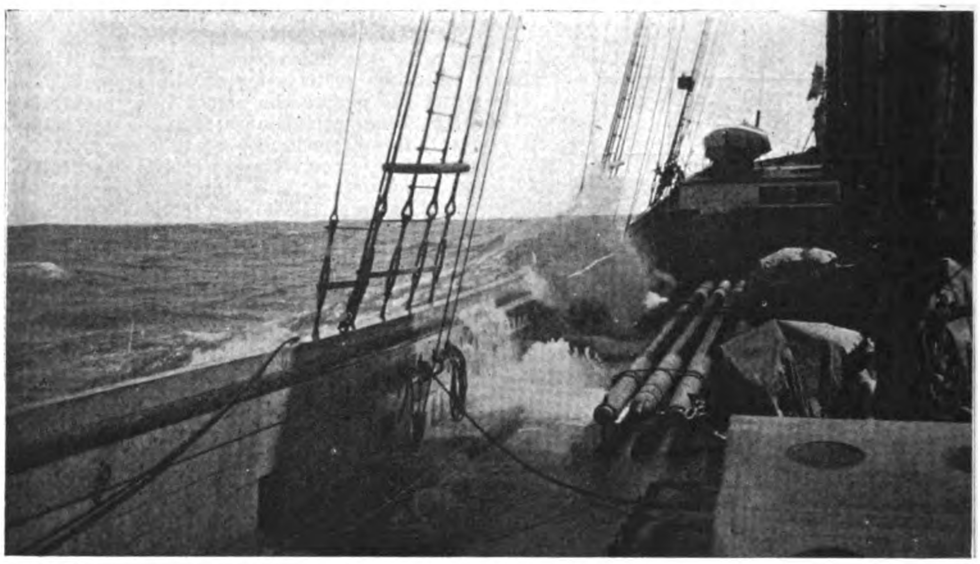
Running time	9 days	
Fuel-oil consumed (Total)	5,150 gal.	(123 bbls.)
Average fuel consumed per day	572 gals.	(14 bbls.)
Lubricating-oil consumed	284 gals.	(6¾ bbls.)
Average lubricating-oil consumed per day	31 gal.	
Kerosene-oil consumed (Total)	297 gal.	(7¼ bbls.)
Coal consumed (Total)	8 tons	

(Lubricating-oil consumption) means oil used by dynamo engine, main engines, all deck machinery and hand use.

Sabine to Claymont, Dec. 10, 1919—Dec. 28, 1919

Running time	11 days
Fuel-oil consumed	7,820 gal.
Average fuel-oil consumed per day	711 gal.
Lubricating-oil consumed	193 gal.
Average lubricating-oil consumed per day	18 gal.
Kerosene-oil consumed	124 gal.
Coal consumed	3 tons

Fuel-oil consumption includes work of engines while aground in Sabine Pass. Engines were worked to their maximum for hours at a time.



Port deck of the "Chas. Gawthrop" in a heavy sea

Fuel and lubricating-oil costs of the motor auxiliary are based on operation at full power for 85 per cent of the time at sea, which more than covers the actual conditions. On this basis this cost per year at present prices would be $8,650.00.

INSURANCE

At present due to several severe losses by the Insurance Companies on *wooden* motor-schooners the rates are very much in favor of the sailing-schooner.

Philadelphia to and including lying days at Matanzas, Cuba, Feb. 6, 1920—Feb. 28, 1920

Running time	7 days
Fuel-oil consumed	4,605 gal.
Average fuel-oil consumed per day	658 gal.
Lubricating-oil consumed	219 gal.
Average lubricating-oil consumed per day	31 gal.
Kerosene-oil consumed	386 gal.
Coal consumed	15 tons

SUMMARY OF OPERATING COSTS PER YEAR

	SAILING SCHOONERS 4 trips	SAILING SCHOONERS 3 trips	MOTOR SCHOONERS 7 trips	MOTOR SCHOONERS 6 trips
Crews' wages	$25,740.00	$25,740.00	$39,120.00	$39,120.00
Food	13,140.00	13,140.00	18,068.00	18,068.00
Fuel and lubricating oil	....	....	8,650.00	8,650.00
Coal and miscellaneous stores	2,000.00	2,000.00	2,000.00	2,000.00
Repairs	12,000.00	12,000.00	18,000.00	18,000.00
Port charges	1,200.00	900.00	2,100.00	1,800.00
Stevedore Charges	8,880.00	6,660.00	13,720.00	11,760.00
Trimming Cargo	800.00	600.00	1,400.00	1,200.00
Ballasting	1,600.00	1,200.00	1,680.00	1,440.00
Insurance	23,310.00	23,310.00	48,510.00	48,510.00
Depreciation on Hull—5%	11,100.00	11,100.00	11,170.00	11,170.00
Depreciation on Machinery—10%	....	....	10,000.00	10,000.00
Total	99,770.00	96,650.00	174,418.00	171,718.00
Earnings	168,720.00	126,540.00	274,400.00	235,200.00
Expenses	99,770.00	96,650.00	174,418.00	171,718.00
Net earnings	68,950.00	29,890.00	99,982.00	63,482.00
	31%	13.4%	30.9%	19.7%

Matanzas to and Including Time at Port Arthur and Sabine, Tex., Feb.28, 1920—Mar. 8, 1920

Running time	5 days
Fuel-oil consumed	3,255 gal.
Average fuel-oil consumed per day	651 gal.
Lubricating-oil consumed	133 gal.
Average lubricating-oil consumed per day	26 gal.
Kerosene-oil consumed	40 gal.
Coal consumed	2 tons

Sabine, Tex., to and Including Time at Tarragona, Spain, Mar. 8, 1920—Apr. 15, 1920

Running time	35 days	
Fuel-oil consumed	20,455 gal.	
Average fuel-oil consumed per day	584 gal.	
Lubricating-oil consumed	739 gal.	
Average Lubricating-oil consumed per day	21 gal.	
Kerosene-oil consumed	170 gal.	—At sea.
Kerosene-oil consumed	168 gal.	—In Tarragona
Coal consumed	12 tons	—At Sea
Coal consumed	15 tons	—In Tarragona

Nine days of this running time was with the starboard engine alone.

Tarragona to Iviza to Gibraltar to New York, Mar. 27, 1920, May 29, 1920.

Running time	23 days
Fuel-oil consumed	15,310 gal.
Average fuel-oil consumed per day	666 gal.
Lubricating-oil consumed	426 gal.
Average per day lubricating oil consumed	18.5 gal.
Kerosene-oil consumed	40 gal.
Coal consumed	5 tons

According to Howard S. Scott, chief-engineer of the "Chas. S. Gawthrop," not a cent was spent in outside engine-repairs for the seven months' operation, such adjustments as were necessary having been taken care of by the engine-room personnel.

[As we go to press we are advised by the representative of the Philippine Vegetable Oil Co. that the "Katherine" is now making a record voyage. From New York to San Francisco she averaged just over 8 knots. She then left 'Frisco at 5 P. M. on July 21st and passed Honolulu at 7 P. M. on July 31st. On August 6th at 8 P. M. she was 1140 nautical-miles west of Honolulu. This is most excellent showing for a vessel of her displacement and power.—Editor.]

Iron Motorship "Tankerville"

Old Steamship Now Bolinder Oil-Engined Combination Freighter and Tanker

BEFORE this issue appears the iron motorship "Tankerville" will have docked somewhere in New York harbor, making quite a little fleet of motorships that have arrived during the past few weeks, of which all but two unfortunately are foreign owned. The "Tankerville" is owned by the Philippine Vegetable Oil Co., of 11 Broadway, New York, and is the third vessel converted to motor power to their order during the last few years.

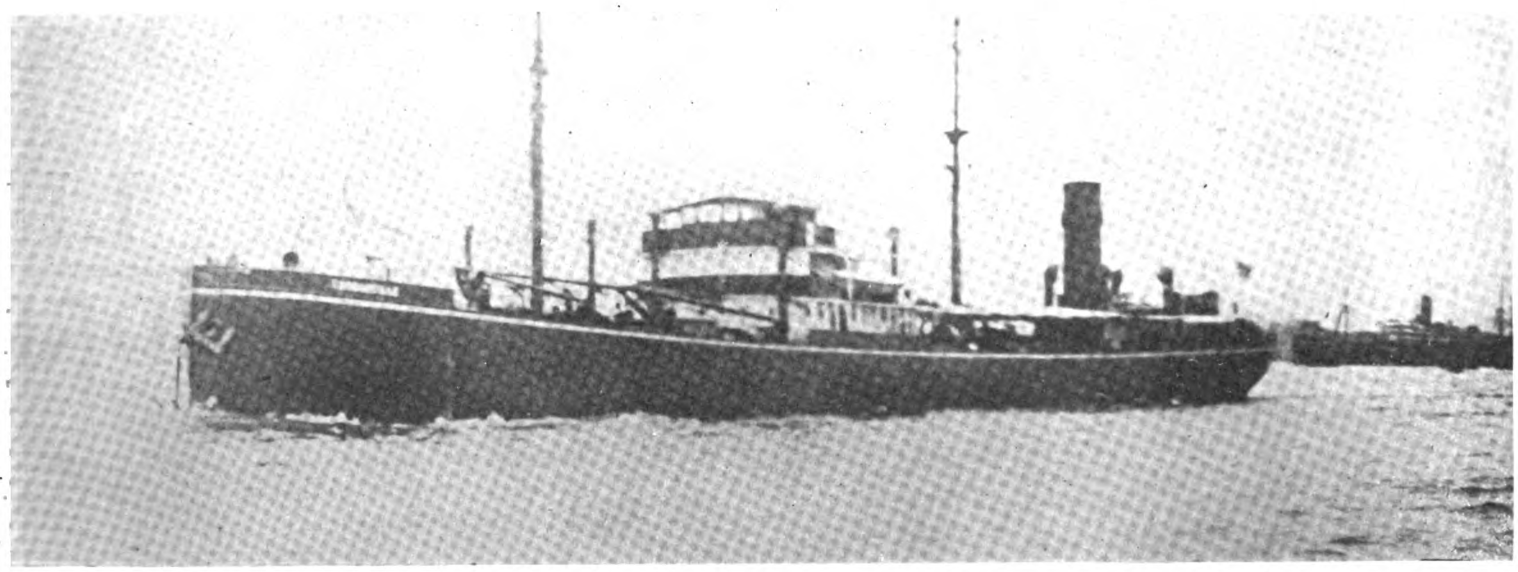
She was originally built in 1889 as a steamer and in 1908 was bought by the Siamese Navy and used as a collier. In 1919-1920 she was completely altered, including the removal of her steam-engines and boilers, by the Hong Kong & Whampoa Dry Dock Co. of Hong Kong, China, and equipped with twin four-cylinder 500 shaft h.p. Bolinder two-cycle, surface-ignition heavy-oil engines of the direct-reversible type, giving her an average speed of about eight knots.

This run to New York from China is her maiden voyage and she made the trip via the Suez Canal and London. Unlike the company's other ships she is designed as a full-powered vessel and so carries no auxiliary canvas. Her dimensions are as follows:

Deadweight Capacity	3305 tons
Weight (net) Cargo Carried	2700 tons
Fuel Capacity	360 tons
Fresh Water (For Donkey-boiler & crew)	350 tons
Length	292 ft. 6 in.
Breadth	37 ft.
Depth	26 ft. 9 in.
Draught (Mean Loaded)	20 ft. 10 in.
Liquid Cargo Capacity	124,610 cu. ft.
Dry Cargo Capacity	29,924 cu. ft.
Total Cubic Capacity	154,534 ft.
Daily Fuel-Consumption About 45 bbls.	(6½ tons)
Average Speed (Loaded)	8 knots
Cruising Radius	10,550 miles

Her auxiliary machinery is partly electric and partly steam. For driving the electric-generators 'Frisco-Standard electric-ignition type distillate-engines are installed. These furnish current for the electric-lighting, refrigerator, etc. A large donkey-boiler is installed with 100 lbs. working pressure, and this supplies steam to six cargo winches, to a 12 in. by 4 in. by 10 in. cargo-pump and for heating purposes. Another of these pumps is to be added in order to increase the speed of handling the liquid cargo.

Shipowners' attention is drawn to the cubic-capacity of the under-deck cargo-space of the "Tankerville," namely 154,534 cubic feet which is considerable for a vessel of her dimensions and compares very favorably with a steamship of her size and cruising radius, namely 55 days.



The Bolinder-engined motorship "Tankerville"

YARROW COMPANY NOT ADOPTING THE POLAR-DIESEL ENGINE

In our June issue a paragraph appeared stating that Yarrow & Co., Ltd., of Glasgow had taken out a Polar license. They—also the Atlas Diesels Motorer Co.—write to advise us that this is incorrect. We gladly publish this correction.

ORIENT STEAMSHIP CO.'S FIRST MOTORSHIP LAUNCHED

About two years ago the Orient Steamship Co. of Copenhagen was formed to take over the steamships of the East Asiatic Co. They themselves are now ordering Diesel motorships. Their first—a vessel of 9,000 tons d.w.c. was launched on July 26th at the Nakskov shipyard. She is 400 feet long by 54 feet beam.

RUSSIAN MOTOR TANKER "BAKU"

There seems to be considerable doubt as to the ownership of the 7900 tons d.w.c. Russian motorship "Baku." Originally she was built at Nicolaieff to the order of Ljanosoff, the oil king, and fitted with Krupp Diesel engines. Then she was in the hands of Generals Denekin and Wrangel, and now it seems possible that she will be operated by the Nobels Naphtha Products Co. The "Baku" is an exact duplicate of the "Glenpool" (ex-"Hagen") and the "Loke."

MOTOR TANKSHIP "MEXICO'S" MAIDEN VOYAGE

The new 4700 tons d.wc. motor tankship "Mexico," built for the East Asiatic Co. for the purpose of fueling their large motorship fleet, recently arrived in New York from Copenhagen on her maiden voyage in ballast. She took on a cargo of oil-fuel at Bayonne from the Standard Oil Co.'s wharf, but sailed again a few days later before we were able to go aboard her. Her propelling plant consists of two 800 shaft h.p. Holeby Diesel engines. A description of her was given in our issue of March, 1920. On account of bad weather her voyage to New York took 20 days. Her speed was 10 knots average in ballast. Her engine-room crew consists of a total of 11 men.

SCHNEIDER ET CIE'S NEW ENTERPRISE

Schneider et Cie, the great French engineers and Diesel-engine builders, of Le Creusot, and of New York, have purchased 40,000 shares in the Skoda Works, Pilsen, Austria, as well as investing a huge sum in the Berg and Huetten Mining and Smelting Company, which is one of the biggest concerns in Austria. They have placed three of their men on the board of the Skoda Company and have increased the capital to 144,000,000 crowns. Last year, "Motorship" issued a beautiful 72-page Art Supplement dealing with the wonderful War and Peace work of Schneider et Cie. It was the most magnificent specimen of printing ever produced by a marine publication, and a copy was sent to every one of our subscribers. Licenses to build the Schneider merchant-ship type Diesel-engines are available to responsible American engineering and shipbuilding companies. We have several bound copies left of the 1920 volume of "Motorship" and these contain the Schneider Supplement. Total price, $8.00 each, postage extra, weight 5 lbs.